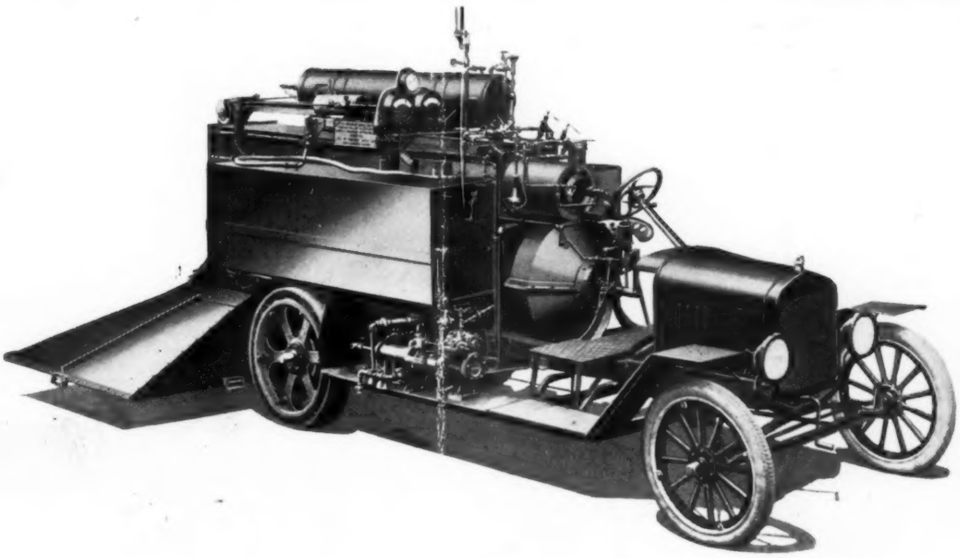
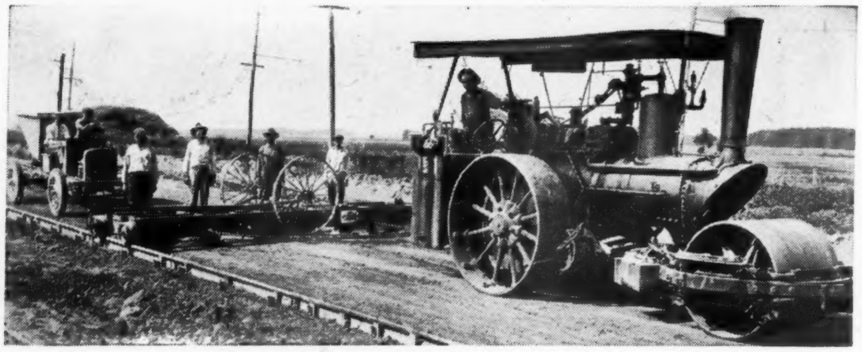
PUBLIC WORKS

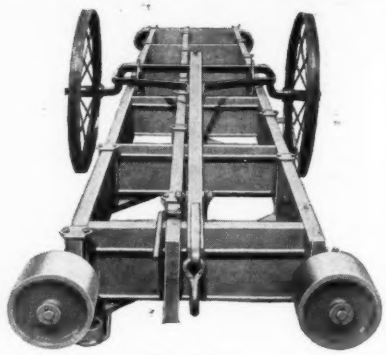
CITY COUNTY STATE



APRIL, 1923

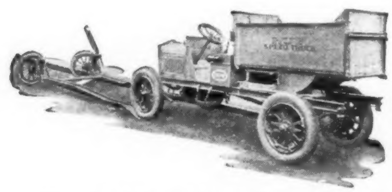


The Hug Subgrading Machine in position on the subgrade.



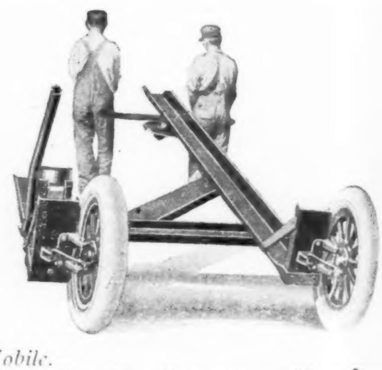
Top View
Showing Rugged Construction.

Turntable of Simple Design.



Truck Approaching Turntable.

Turned by Truck's Own Power Between Forms.



Mobile.
Only Two Men Necessary to Move It.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 54 April, 1923 No. 4

Unusual Features of a Florida Concrete Road

A contractor from Iowa lays 43 miles of concrete road in Florida, using stone from South Carolina, sand from 200 miles away and cement from 400 miles. Plant used in averaging more than a thousand feet a day.

By M. C. Winterburn*

It is one thing to build a concrete road in "your own back yard," but the building of forty-three miles in a section far removed from material sources and where practically all conditions are new, and furthermore to complete the same in one year's time, is quite another.

This is what C. F. Lytle, of Sioux City, Iowa, has been doing the past year. Early in 1922 Mr. Lytle contracted with the Florida State Road Department to build Federal Aid Projects Nos. 11, 21, 22 and 23, consisting of 43 miles of concrete road between Jacksonville and Lake City, Florida—one of the longest continuous pieces of road ever paved under one contract. This contract extends from the end of a brick road, seven miles west of Jacksonville, to a point about ten miles east of Lake City, the road being known as State Road No. 1.

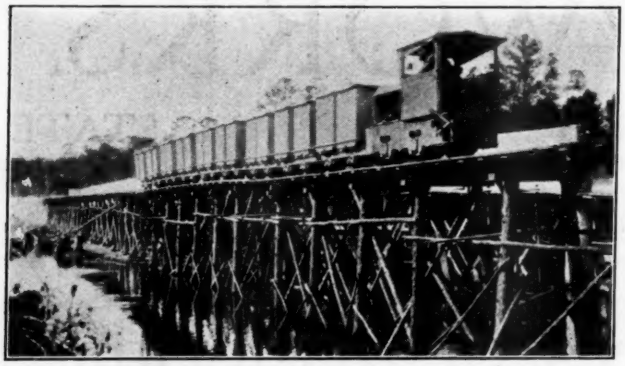
The highway parallels the Seaboard Railroad the entire distance, lying north of it for 30 miles and then crossing to the south side. The highway also crosses the A. C. L. R. R. At 23 miles from the east end it crosses Little St. Mary's River, where a trestle was used for industrial track.

An humble start at pouring concrete was made on May 15, 1922, about 40 miles had been completed early in April and it is believed that the entire work will be completed by May 12. Every road contractor will appreciate the amount of effort expended in assembling the necessary equipment and organizing the man power for a job of this magnitude and keeping up an average of nearly a thousand feet a day for fifty consecutive weeks.

On March 22 the entire road had been completed for a little over 35 miles, and it was expected that by April 20th about 4¾ miles more would be completed, an average of a thousand feet for every day elapsed except Sundays.

*Superintendent for C. F. Lytle.

A SECTION OF FINISHED ROAD, SHOWING CULVERT. RAILROAD IN BACKGROUND.



TEMPORARY TRESTLE OVER LITTLE ST. MARY'S RIVER.

This trestle was over 800 feet long and was built to carry the industrial track for transporting the concrete aggregate from the central bins to the mixer. A train of batch boxes is seen crossing.

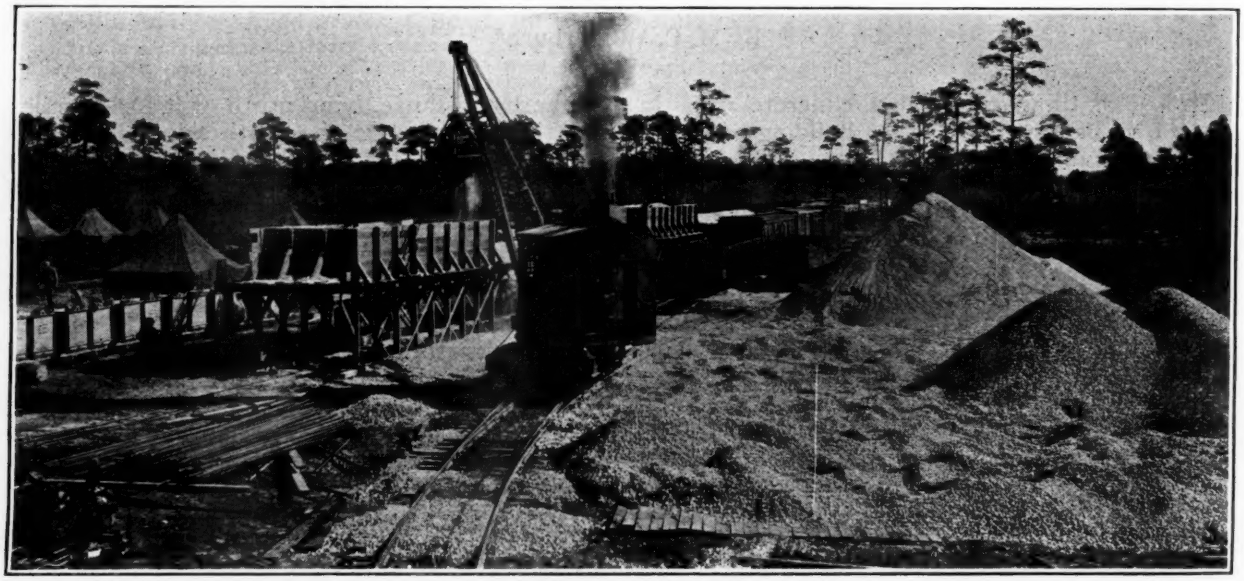
The pavement is sixteen feet in width and the thickness is 6-7½-6 inches, with expansion joints placed every forty-five feet.

PREPARING SUBGRADE

Most of the soil is very sandy and a very hard and uniform sub-grade is made by the "flooding" method. This method was carried on as follows. After the forms have been set and the road brought to approximate grade, it is flooded with water. After this has dried sufficiently, it is rolled and a final cut made with a Lakewood sub-grader, bringing the roadway to finish grade. It is again flooded and when the water has soaked away the sub-grade is left very hard and in excellent shape for paving. To avoid absorption of water from the concrete, the sub-grade is generously wet down just ahead of the mixer.

HANDLING MATERIALS

One of the most interesting features of this project was the material supply. Crushed rock, of which eighteen hundred cars are required, is shipped from Columbia, South Carolina, an average distance to the proportioning plants of over three hundred miles. Nine hundred cars of sand will have been transported an average of two hundred miles and nearly six hundred cars of cement will have been shipped from points over four hundred miles from the work. In all, a rail haul of 45,000,000 ton-miles will be required to supply the necessary materials for the job or, figuring the length of the average car to be forty feet, a freight train twenty-five miles long is required in hauling the material for this forty-three miles of road.



VIEW OF PLANT AT McCLENNEY, NEAR LITTLE ST. MARY'S RIVER.

Crane is seen filling bins with rock and sand. Track running under bins carries industrial cars, each with two batch boxes, which are filled from the bins by gravity. Eight batches are loaded at one spot. Workmen's tents are seen at the left.

The material was handled from five propor-

MAKING SUBGRADE.

The roller is compacting the sand between the side forms, which are shown. At the right is the industrial track. Behind the roller the subgrade is being surfaced by means of a subgrader. The top of the concrete mixer is seen in the far background. This stretch was almost impassable before being paved.

tioning plants, the first being located 4.25 miles from the east end of the project and others at intervals of 8.5 miles from this point to the west. Thus about 8.5 miles or approximately 80,000 yards were paved from each plant with an average industrial haul of 2.15 miles.

THE PLANT USED

Each plant consisted of standard gage track to accommodate 14 cars of crushed rock and sand and 5 cars of cement at each spot. The rock and sand hoppers were designed to hold 150 tons each. Cement was handled direct from cars to batch boxes, no attempt being made to store any particular quantity of this material. Rough material was handled from the cars and to the hoppers with two Orton & Steinbrenner locomotive cranes, one working at the proportioning plant in operation and the other "stocking up" at the location of the next set up.

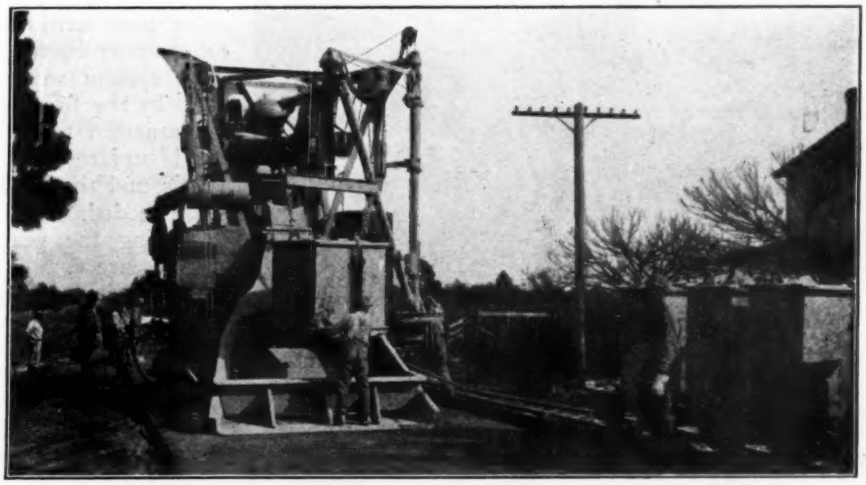
One hundred and fifty Koppel batch boxes each of 48 cu. ft. capacity, with 85 Koppel cars and five miles of Koppel 24-inch gage track, together with five Whitcomb gasoline locomotives (one of which was used as a switch engine) comprised the transportation equipment.

One Koehring 32 and one Austin 28 mixed the concrete, which was finished with Lakewood

WORKMEN'S LIVING QUARTERS.
Above: Mess hall and white men's quarters. Below: Quarters for colored labor.

machines, four of these being kept on hand. Two Austin 10-ton gas road rollers and two Lakewood sub-graders were used in preparing sub-grade. Ten thousand feet of Heltzel steel forms were employed. Four Domestic pumps

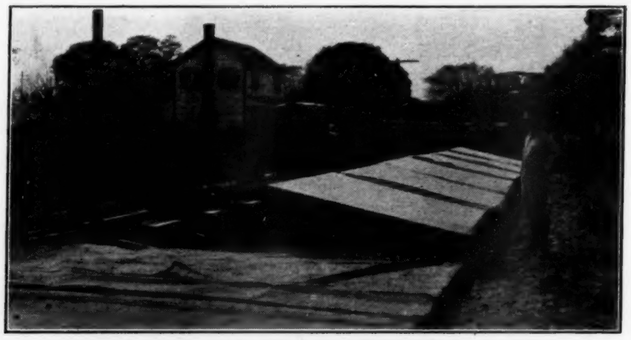
CONCRETE MIXERS.
At the right is seen the Koehring mixer in action, and below the Austin. The batch boxes are swung over to the skip by the attached crane of the former; the latter lifts the boxes by means of jib and traveling hoist. In each case a complete batch is discharged into the mixer from one box.



furnished water through eight miles of 2-inch pipe from fifteen batteries of 2-inch wells ranging in depth from 130 to 220 feet.

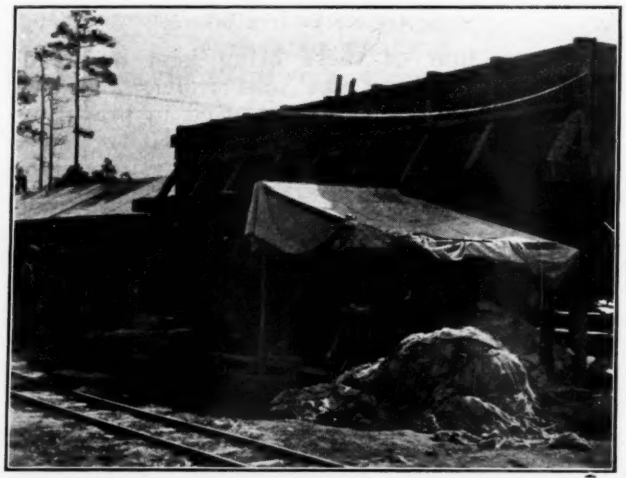
Twenty 16 x 16 squad tents with wooden floors and sides, well screened, provided quarters for the men. A mess hall feeding 120 at one time, whites at one end, colored labor at the other with kitchen between, came in for particular attention three times per day. A well equipped repair shop was installed in charge of expert mechanics to take care of all mechanical repairs. The entire plant and camp was efficiently lighted by the use of a portable Fairbanks-Morse lighting plant. Two smaller plants were used in making night repairs on the road.

Moving from one setup to another, which involved a "leap-frog" performance, was not the least important detail. This meant the transferring of all plant equipment except the standard gage track, all camp equipment,



COVERING FRESHLY LAID CONCRETE
Elevated canvas covers are placed over the new concrete. Later the canvas is allowed to rest on the concrete. After the first day the concrete is kept covered with damp earth. A train carrying 24 batch boxes is seen in the background.

one mixing and sub-grading outfit as well as taking up, moving and relaying five miles of industrial track and about the same



CLEANING AND BUNDLING CEMENT BAGS
About three thousand sacks are cleaned and bundled per day, at considerable profit to the contractor. In the background is seen a canvas-covered train shed.

amount of water pipe. This work was prosecuted day and night with the result that the

THE RESPONSIBLE PARTIES
From left to right: C. A. Root, resident engineer; E. E. Albee, Federal Government inspector; M. C. Winterburn, superintendent; John R. Slade, testing engineer.

move from plant No. 4 to plant No. 5 was accomplished in 50 hours and caused the loss of only two days of mixing time.

At no time during the progress of the job has any attempt been made to make a record run, but every effort is made to get the most out of every day. As a result of this continuous effort, 8.75 miles or nearly 83,000 square yards of pavement was laid and a move made between January 30th and March 24th, an elapsed time of 54 days which included 7 Sundays and 3½ days lost on account of rain; giving an average per working day of 1,062 lineal feet, or 1,888 sq. yds.; or 855½ feet per day of elapsed time. The average for the entire year, including Sundays, holidays and all, from the date of the first pouring, is about 630 feet.

South Carolina Highways

The State Highway system of South Carolina, on January 1, 1923, contained 3,519 miles, of which 3,225 miles had been proposed for Federal aid. Based on 7% of the public road mileage of the State, 3,662 miles is eligible for federal aid.

During 1922, 73 miles of hard surface roads were constructed, giving a total of 158.8 miles of hard surface constructed to date, while 41 miles were under contract. During the year 475 miles of types other than hard surface were constructed and 225 miles under contract. Altogether 2,307 miles of the state system were either improved or under contract by the first of this year. The State Highway Commission reported that 300 additional miles of hard surface were needed to care for the present traffic and that 913 additional miles of other types were needed.

During the year surveys made for which the records are complete totalled 215.85 miles, the cost of this work being $16,047, an average cost of $74.34 per mile. Plans were prepared for 440 miles at an average cost of $48.10 per mile.

Seventy-four contracts were let during the year, the greatest number in any one month being 14 in May, 16 having been let prior to that month. The unit costs of the successful bids during the entire year averaged as follows: Clearing and grubbing $91.77 per acre, common excavation 26c per cubic yard, rock excavation dry $1.67 per cubic yard, rock excavation wet $4.66 per cubic yard, top soil surfacing 27c per cubic yard, sand-clay surfacing 24.7c per cubic yard, clay-gravel surfacing 23c per cubic yard, clay bound macadam 46.5c per square yard, shaping subgrade $2.00 per thousand lineal feet, gravel surfacing $1.37 per cubic yard, bituminous concrete surfacing 94.7c per square yard, plain concrete surfacing $2.48 per square yard, reinforced concrete surfacing $2.87 per square yard, concrete base $1.51 per square yard, sheet asphalt surface 98.5c per square yard, rock asphalt pavement $2.06 per square yard, shell surfacing 78c per square yard, Class A concrete $20.83 per cubic yard, Class B concrete $18.22 per cubic yard, Class C concrete $20.25 per cubic yard.

The cost of pipe culverts was materially reduced by requiring all pipe for state department work to be purchased from one producer. This resulted in

somewhat better prices and, on account of inspection of manufacture at the plant, a better quality of pipe.

At the beginning of 1922 the state had under maintenance 1,319 miles and at the end of the year 1,910 miles, an average of 1,603 miles during the year. The total cost of state maintenance was $382,361, an average of $240.68 per mile. The Commission states: "In considering the cost per mile for maintenance, it should be remembered that the funds available for maintenance in some of the counties have been altogether insufficient and in those cases the roads have suffered in consequence."

The principal additions to the completed mileage were in the Calhoun Highway which extends across the state, and about 20 miles to the old "Ninety-six Road."

The cost of surveys in 1921 averaged $59.14 per mile, the increase in 1922 being due largely to the increased proportion of work in the mountainous portions of the state. For the same reason the cost of preparing road plans increased from $40.54 in 1921 to $48.10 in 1922. Surveys and plans for bridges averaged 97c. per foot of bridge planned or 1.75% of the total estimated cost.

Wet Excavation by Dragline Cableway

The hydraulic canal and forebay of the Cohoes, New York, Power and Light Corporation has been enlarged as part of the project for increasing the capacity of the hydro-electric plant and providing power for various industries which formerly used the canal for their individual power plants. It was necessary that this work be performed without interfering with the operation of the hydro-electric plant and that the equipment handle wet material which ranged from a sticky mixture of clay and loam to shale rock which could be removed with very little blasting.

The contract for this work was let to Sanderson & Porter. For the excavating they used a 400-foot span 1-cubic-yard Sauerman dragline cableway excavator. Excavation was begun in May, 1922, and in this month 7,200 cubic yards of earth under water were excavated. During June, 4,650 cubic yards of earth and 2,630 cubic yards of rock were removed. During part of both months the cableway operated 18 hours a day in two shifts. Very little drilling or blasting was necessary as the excavator was sufficiently powerful to bring up most of the shale without blasting. The best day's record was 547½ cubic yards, but the contractors state that 60 cubic yards could be handled in one hour when conditions were just right. The field engineer in charge of the work for the contractor, D. S. Pelletier, estimated that the earth excavation cost 51c. per cubic yard and the rock excavation $1.03.

The excavated material was delivered to a hopper between the canal and the river, the latter of which was nearly 100 feet below the former, and from the hopper the material was sluiced down to the riverbank and used for a fill around the power house. In order to sluice the material, water was pumped into the hopper from the canal by a 6-inch electric centrifugal pump.

The average distance the material was moved by the dragline was 275 feet. The average depth of cut was 6½ feet in an average depth of 15 feet of water.

Broken Stone Bases and Brick Pavements

Discussion of the tests made on the Bates Experimental Highway and some conclusions and lessons drawn therefrom.

By Charles Carroll Brown *

Several designs were used for the brick pavements included among the sections of the Bates Experimental Highway, ranging from a 3-inch brick with 2-inch sand cushion on a 4-inch macadam base, to a 3-inch brick with 1-inch sand cushion on a 6½-inch Portland cement concrete base. Some sections were constructed with bituminous filler and some with Portland cement grout filler. In some sections the bricks were lugless, and in some they had lugs. Almost any combination within these limits may be found in the 28 sections and sub-sections.

BASE

As to base, failures are recorded as occurring when the breaks under traffic have produced separation of small enough areas to cause depression under subsequent applications of loads, so that the impact on the area and on the adjacent edges of the pavement is unduly increased, causing progressive failure of the pavement to extend rapidly out from the break. This follows the practice regarding breaks in the surface of rigid pavements.

The cement-filled brick pavements, especially the monolithic and semi-monolithic types, are considered to be rigid pavements and the bituminous filled brick pavements as flexible surfaces. This is not strictly correct in all cases, however, as there are instances of separation of the brick layer from the base, particularly in semi-monolithic pavements, which occurred even before the test began, and others which occurred after the shocks of the traffic began, and in such cases the bricks soon separated from each other, reducing the rigidity to that of the base alone.

Macadam Bases Under Brick. The sections of brick pavement and one of asphaltic concrete on macadam base were located near a culvert under the road where, on account of the lack of drainage of the road, the water gathered, and as a

*Municipal Consultant, City Engineer of St. Petersburg, Fla.

consequence these sections were for much of the time soaked with water. The advantage of the lower layers of the macadam in preventing the capillary action of the water (constantly in the clay of the sub-base) from reaching the wearing surface was therefore lost, and as a consequence the tests gave no information regarding the value of a macadam base under ordinary and reasonable conditions.

Under these conditions, which were much worse than those existing in practically all the remainder of the highway, the results were as follows:

For the first test, each front wheel carried 1,250 lbs. (250 lbs. per in. width of tire), and each rear wheel carried 2,500 lbs. (450 lbs. per inch width of tire). The trucks made 1,000 trips in the aggregate, of which 500 were made up and down the center, except when passing each other, and 500 were made up one side and down the other, with wheels 18 inches from edge of pavement.

There were no failures of brick pavement on macadam base. There was practically complete failure along the wheel tracks of Section 10, 2-inch asphaltic concrete (Topeka mix), on 4-inch Novaculite base, and there were three failures in a section of 2-inch Topeka mix on 4-inch macadam base. There were three breaks on a 3-inch brick pavement with 1-inch sand cushion on 6½-inch concrete base; from one to three small breaks on each of five sections of 3 or 4-inch brick on 2 and 3-inch concrete base, monolithic and semi-monolithic construction. There were two breaks each on a section of 4-inch Portland cement concrete on 4-inch broken stone base.

For this small amount of light truck traffic the macadam base shows up well, notwithstanding its handicap as to drainage conditions.

For the second test, 3-ton trucks were used, and the load was increased to 2,150 lbs. on each front wheel (430 lbs. per inch width), and 3,500 lbs. on each rear wheel (350 lbs. per inch width). For 627 trips of trucks, the wheels traveled on the edges of the pavement, but thereafter for the full period of the test the trucks ran west with the outside rear wheels 2½ ft. from the north edge and came back along the south edge. Warmer weather in May expanded the pavement so that the free corners of slabs were more or less completely held in place by the binding action of the tightly crowded adjacent slab. To reduce the slabs to normal conditions of cooler weather, a 1-inch cut was made through each section of rigid type, the joint thus formed being filled with asphalt. After this the last 1,000 trips of trucks in this second set were made.

The curling up of the edges of the pavement at night having been discovered, 1,033 of the 3,200 trips of this set were made at night.

The loads used produced strains in 4-inch bases or rigid pavement which were so near the ultimate strength of slabs of this thickness that they might be expected to fail under 3,200 applications. The same would be true of the rigid or semi-rigid wearing surfaces on macadam bases. Such bases might themselves be expected to give way on so poor a foundation as they had, emphasized as this was by the extra amount of water almost always present on the sections of the highway in which most of them were located.

In fact, the sections of 3-inch and 4-inch lug and lugless brick on 4-inch broken stone base with 2-inch sand cushion, with bituminous filler, were considered to have failed after 1,000 trips of the second set or 2,000 trips in all, the failures taking place along wheel tracks. The sections of 4-inch and 3-inch lugless brick with 1-inch and 2-inch mastic cushion, 8-inch broken stone base and bituminous filler, lasted but little longer, failing rapidly after 1,500 trips of the second set, or 2,500 trips in all.

Macadam Under Asphalt. The best comparison of strength of macadam base is found in the action of the various thicknesses under asphaltic concrete wearing surface.

With 2-inch Topeka mix and 4-inch broken stone base, there was practically continuous and complete failure after the second set of 3,200 trips of 3,500-lb. load, following the 1,000 trips of 2,500-lb. load in the first set. With 4-inch Novaculite base the failure was complete under the first set—1,000 trips with 2,500-lb. load.

With 6-inch macadam base there were six points of incipient failure under the second set of trips; two additional points of incipient failure under the third set of 3,000 trips of 4,500-lb. load; practically complete failure under the fourth set of trips with 3,000 trips of 5,500-lb. loads. The fifth set of trips, 3,000 with 6,500-lb. loads and 3,000 trips of the sixth set with 19,860-lb. loads (8,000 lbs. on each rear wheel), were run over this section. Observation by the writer on October 13 showed the section to be in fairly usable condition for light traffic, with one break and some depressions along the south side where the truck wheels ran along the edge of the pavement.

With 8-inch macadam base there were six failures of apparently decisive character under the second set of trips; eight points of decisive failure, nine points of incipient failure and five points of progressive failure, this loading being considered in excess of the capacity of the pavement. The fourth and fifth sets of trips and 3,000 trips of the sixth set were run over the section, with similar notations regarding effects of loads. Observation by the writer showed poor condition with many breaks and with considerable depressions along the south side.

With 10-inch macadam base there were three failures under the second set of loads; three additional failures and two points of progressive failure under the third set of loads, which is considered the limit of strength of this type. Similar notation is made regarding loads and additional failures under fourth, fifth and part of sixth sets of trips, and the writer's observation showed the portion of the section most nearly out of water to be in fair condition for light traffic.

That the relative value of these macadam bases under the same Topeka mix top is not in proportion to their thickness, but is more nearly according to their distance from the bottom of the

slope where the soaking with water was most continuous, is very strongly indicated by the official reports and by the writer's observations, which were made without noticing the relative depth of macadam base.

That the forcing of the macadam into the sub-grade, softened by water, was the cause of the rutting of the brick pavements on macadam base was also evident, without reference to thickness of base. The sections with 8-inch macadam base were farther down the slope toward the culvert than those with 4-inch base. In other words, the test was a failure so far as ability to make reasonable comparison between macadam bases of different thickness and material is concerned or between macadam and other bases, mainly because they were located in the worst conditions on a road which is in general located where the conditions can hardly be equalled for badness except possibly in Illinois.

To make the record complete it may be said that Section 8 varies from those above described by having 1½-inch Topeka surface with 1½-inch binder course on 5-inch macadam base. It had no apparent failures under the first and second sets of trips; two points of incipient failure under the third; two additional points and one point of progressive failure under the fourth. It stood up so well that after 1,000 applications of the load of the fifth set of trips, water was poured into three short trenches along the south edge of the pavement and these trenches were then filled with tamped Novaculite. During the passage of the other 2,000 loads of the set there were failures at each of these points, and the conclusion is drawn that the sub-grade under this section would have failed earlier if the previous sets of trips had occurred during the spring conditions when the sub-grade is highly saturated. It does not seem to have occurred to any one that the better quality of this section might be due to better design of the pavement rather than to better conditions of moisture in the sub-grade. The writer's note regarding the appearance of this section during his visit in October reads: "Fair condition except one break and some depressions along the south side. Section 6 was partly in the water near the culvert and Sections 7, 8, 9, were in order going up the slight slope, with little if any difference in sub-grade, so far as surface indications were concerned."

Another section may throw more light on this subject. Section 58 is of 4 inches of 1-2-3½ concrete on 4-inch rolled stone base course. This section had two corner failures under the first set of trips; another corner failure, indecisive, under the second set; another adjacent to previously broken corner, also indecisive, under the third set. Thus far this section was doing so much better than other concrete pavements of 4-inch, 5-inch and even greater thickness, that similar supposition of drying out of sub-grade was apparently made; at any rate, after 1,750 applications of the fourth load, 2,000 gallons of water were run into the rolled stone base. Two additional corner failures, one with progressive breaking, occurred during this set of trips after this was done. Other breaks occurred under the fifth set of trips and it was noted that the limit of this pavement was reached under the fourth set. Traffic was continued through the fifth set of trips and the 5,000 day trips of the sixth set with maximum loads, but was discontinued then so that the last 5,000 night trips did not pass over it. The writer's notes show that this section is most of it in good condition except a number of cracks and two depressions along the south side and breaks at joints. It was in much better condition than Section 57, and Sections 59, 60, 61A, 61B, were destroyed. Again it does not seem to have occurred to any one that the pavement was in better condition because it was better designed.

BASE DESIGNS SUGGESTED BY TEST

The writer has been studying durability of pavements laid on sand base with and without proper drainage and with or without waterproof surfaces and working out designs for improvements in them. He is therefore in the proper state of mind to take the results of the tests of the above named sections of the Bates Highway and apply them in his design.

In the first place, it is desirable to carry away the water from a pavement as rapidly and completely as possible.

In the second place, if this cannot be done and the sub-grade has strong capillarity, it is necessary to stop the passage of this water up to and through the pavement.

Third, it is necessary to make the surface waterproof and the drainage from the surface complete, so that the surface water will not get down through the pavement or the shoulders to add to the water troubles below.

To meet these requirements, it may be possible to construct a base for the pavement which will be waterproof and flexible enough to follow the motion of the sub-grade, and at the same time cohesive enough to distribute loads over enough area of the sub-base so that there will not be undue settlement on account of the compression of the sub-base. It is possible to construct a wearing surface at the same time waterproof and flexible enough to follow slight movements of the base and still retain its surface practically intact and its ability to distribute loads on its units over the base.

These experiments on macadam bases, while they are incomplete and inconclusive, on account of the neglect to consider conditions and to fit the designs to those conditions, and while they eliminated the most important of these designs from consideration, point the way toward a series of designs and tests of pavements constructed from them which bid fair to be improvements over designs that have been tested, both in quality and in cost.

The apparent drying out of the sub-grade is probably due to the porosity of the broken stone layers rather than any special condition under these sections which differentiates them from immediately adjacent sections. The numbers of the sections show that the concrete section is far from the asphaltic concrete section. The lack of the same action in the macadam under

the brick sections and the lower asphaltic concrete sections is definitely due to the backing up of water on account of the total absence of drainage at that point. Even with the neglect of either surface or subsoil drainage, it seems to be possible for the broken stone layer under the sections located above the depression at the culvert to drain itself and to bind itself with the clay sub-grade close enough to keep its place and do its duty in transmitting loads from the pavement above to the sub-grade below and distribute them so long as they are not excessive, whether the pavement is rigid or flexible. Where the water cannot drain off, the observations and reports show that this distribution of the loads does not occur, but the brick and asphaltic concrete pavements rut badly under the lighter loads of the test runs.

Both the asphaltic concrete and the cement concrete pavements are waterproof until they crack, and the filling of the cracks is a simple and rather inexpensive problem of the maintenance department. Both of them seem to be able to stand the wear of traffic, cement concrete probably being the better in this regard; and the asphaltic concrete pavement is the better able to follow any slight movements of the sub-grade, on account of variations in its condition. The asphaltic concrete pavement and bituminous filled block pavements are not subject to curling up at night.

The writer is working out a design for a base composed of broken stone, the lower portion of the layer to be open and so graded as to carry all water getting into it to outlets located conveniently and frequently. The upper portion of the layer is to be filled with bitumen. On this base any wearing surface can be laid, rigid if condition of subsoil is constant or its movement is slight; flexible, if such movements are great enough to demand it. The wearing surface in any event is to be waterproof and drained to outlets in such manner as to keep water out of the subsoil under or adjacent to the pavement, and enough of the base is to be porous to prevent water reaching the bottom of the wearing surface through capillary action.

The thickness of this base and the proportion of it to be filled with bitumen are questions to be answered with full knowledge of the conditions of the subsoil, and weight and character of loads to be carried as the principal points of consideration.

The tests described above, although woefully deficient, seem to indicate that these thicknesses will not be excessive, and that if the cost of drainage is not excessive, the cost of some design of this sort may be less than one providing for a slab thick enough and with enough reinforcement to answer the purpose of carrying the same loads.

The cost of drainage should really not be considered in comparing designs, because every cent spent in drainage will be returned many times from the savings in cost of maintenance, no matter what the design or the surface material.

To the writer the indications are too definite to be disregarded, that if the brick pavement sections on macadam base, and some of the asphaltic concrete on macadam base, had been located even as favorably as most of the other sections, they would have made a much better showing; also that it would be better policy to change designs to take advantage of the good service given by the broken stone bases where they could perform one of their chief functions (keeping the pavement dry), rather than to lower these conditions to suit those of other sections, which are undoubtedly less satisfactory because the designs of those pavements are less efficient.

BRICK SURFACES

The conclusion from the preceding argument seems to be that the reason for the failure of pavements on macadam bases is, first, the movement of the material in the base course or of the soil underneath, and, second, the ability of the surface to accommodate itself to reasonably slight movements of the same. The application of the latter conclusion is of course to comparatively light loads, proportionate to the strength of the design.

The 8-inch bases were in the water and the brick pavements nearest out of the water were 3-inch blocks on 4-inch macadam base. The tests are therefore of no value so far as brick pavements on macadam base are concerned. They merely corroborate the experience of many years. This applies to Sections 1 to 5, inclusive.

The sections from 23A to 32B, inclusive, had bitumen-filled joints and stone concrete bases from 6½ inches to 3½ inches thick. Most of them were of 3-inch brick, only two having 4-inch brick. Any comparison of lug and lugless brick was negatived by the major operation of cutting a joint in each of many sections, most of which, in the brick pavements, happened to come in the sections or parts of sections laid with lug brick. It may be doubted whether the cutting of this joint was advisable. It is reported to have been done because the expansion of the pavement under the heat of May caused the sections to crowd and thus support each other, and so to increase the strength of the corners of the various slabs. The operation certainly put a stop to the co-operation of adjoining blocks, but it added another line of weakness which apparently increased very seriously the effect of the traffic on the sections so cut. Most of the sections had 1-inch sand cushions, one having 1-inch mastic cushion and one having a 1-inch cement-sand cushion. Most of the bases were of 1-2-3½ concrete, only four being 1-3-5.

Comparisons of sections on any of the points above mentioned show discrepancies and anomalies indicating that some factor or factors of influence have not been recognized in making the designs, and search must be made for them. Close study of these results may suggest possibilities. A preliminary study shows the following, much of which agrees fairly well with the comparisons made in the final "News Bulletin No. 7," issued by the Illinois Division of Highways.

Sections 23A and B, and 24, of 3-inch blocks,

1-inch sand cushion and 6½-inch base, were intact except along the artificially cut joints, and at southeast corner of Section 24, indicating successful passage of test if this outrage had not been perpetrated, even if joints had been properly designed and constructed originally to allow for full expansion. Section 25 with mastic joint was intact. It is probable, as suggested elsewhere in the official report, that shifting of the sand cushion under the disturbance of cutting the joints induced the disintegration started along them.

Sections 26A and B, of 4-inch blocks on 1-inch sand cushion and 4-inch concrete base, were both failures in the official report—A under the second set of loads, and B under the sixth. A was injured in areas extending both sides of the cut joint on the south side and west of the joint on the east side, while B gave very slight indications of failure anywhere. There seem to be no reasons for the difference except the presence of the cut joint.

Sections 27 to 32B, of 3-inch block on 1-inch sand cushion (except 31 on 1-inch sand-cement cushion), on 4½ or 3½-inch base, give results indicating that the unknown factors have more effect than the designed variations. There is some indication that the 1-3-5 concrete of Sections 29 and 32 is not so strong as the 1-2-3½ concrete of the others. Section 31 with sand-cement cushion seems to be in somewhat better condition than the others. The differences in thickness of foundation, 3½ inches in 30, 31 and 32, and 4½ inches in 27, 28 and 29, do not seem to be indicated by the difference in conditions of the sections. The disintegration starts from the cut joints in many cases, indicating probability of movement of sand cushion. The official report shows depression of rows of brick over cracks in foundation before the test was begun, attributed to sand running down into such cracks and leaving brick unsupported. Anomalies in the time that disintegration began to be noticeable are noted in the official report, which were not so definite in an inspection after the tests were finished. The ultimate condition is more nearly proportional to the strength of the design. This may indicate that the assumed movement of the sand cushion is due to various causes and occurs at various times, so that in the course of the tests it produces similar final results, modified somewhat by the other variables. This makes still stronger the argument for a mastic cushion, made in the official report.

Experience on city streets for many years has been such that a brick pavement on less than 6-inch foundation would not be expected to stand under the sixth set of loads, so that here again the tests have told us nothing new. They really indicate that a brick pavement can be constructed somewhat lighter than has been customary, if the traffic is of medium weight, with little regard to its frequency. Five thousand applications of a 10-ton load in 20 days' running time, or even in 37 days of the total time of the last test, is more than 10-inch pavements (4-inch brick and 6-inch base, not including cushion) have been expected to stand in city streets under good drainage conditions. A country road under almost the worst of drainage conditions could not be expected to do as well. The lesson really taught is that a 6½-inch pavement (3-inch brick on 3½-inch concrete base), especially when furnished with a mastic cushion, is equal to the duty which has been expected heretofore of the 10-inch pavement, or even more.

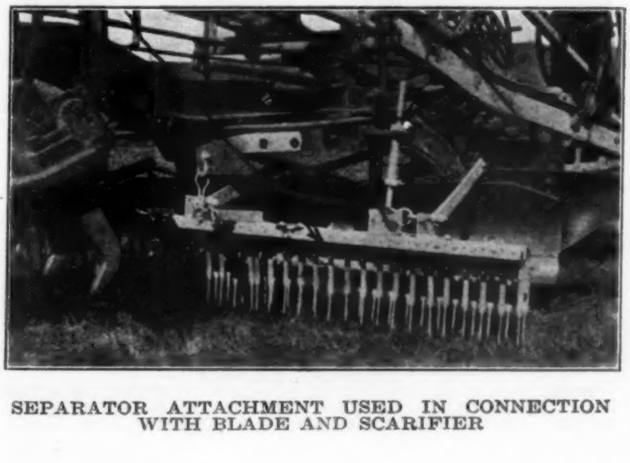
This is indicated also by the tests on monolithic brick sections 33 to 39, inclusive, which vary from 3-inch brick and 2-inch base to 4-inch brick and 4-inch base. However, these sections show the same defects as all the monolithic sections not inordinately heavy, due undoubtedly to the same causes—the expected compression of the unstable wet foundation under loads, especially at the corners of the sections or at intersections of temperature or other shrinkage cracks; and the unexpected curling up of the pavement edges in the cooler parts of the 24 hours.

Here again we have definite corroboration of opinions and observations already fairly well established and indication that such construction is even better than might be expected, especially under the very poor soil conditions of these experiments.

New Method of Gravel Road Construction

In the construction of gravel roads in Oregon and in the reconstruction of old roads a new method has been developed known as the "O'Neil Process." The aim of this process is to eliminate the non-uniformity and the existence of occasional soft spots in such roads by grading the material on the road in an inexpensive manner. In this grading advantage is taken of the fact that larger stones always roll to the foot of a gravel pile. Consequently, if a gravel pile can be advanced progressively across the road, the larger stones continually rolling to the foot of the pile will place themselves automatically at the bottom while the finer material is drawn over them to form the wearing surface.

In the O'Neil process the gravel is dumped in



SEPARATOR ATTACHMENT USED IN CONNECTION WITH BLADE AND SCARIFIER

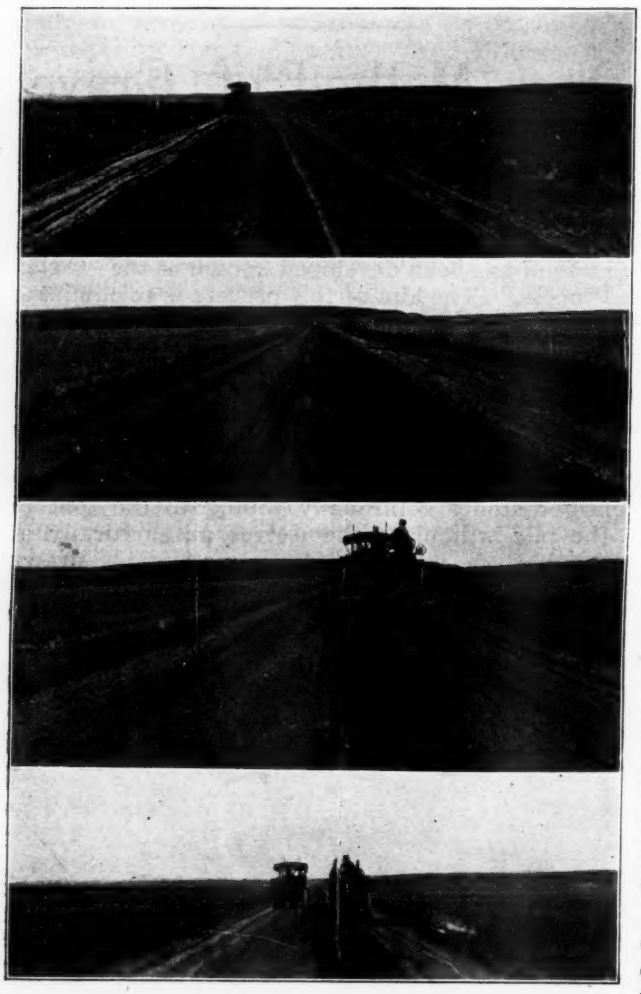
piles or in a continuous ridge along the center line of the subgrade, at least one-half mile of road being treated at a time. A round trip is generally made with the blade grader pulled by a tractor (caterpillar preferred), giving the piles or ridge of gravel a uniform shape and a uniform width of about 8 or 10 feet at the bottom. The ridge so formed is then divided into two ridges as nearly as practicable of the same size by running the blade grader down the ridge a number of times, the two ridges being worked toward the sides of the road until their inside adjacent slopes are approximately 8 feet apart and their outside edges along the line where the finished surface will come, the central valley being carried down to subgrade. A special wing attachment to the grade has been designed by Mr. O'Neil for performing this. While the gravel is thus being worked out from the center it is given a thorough mixing, eliminating all stone clusters.

The two ridges are then worked back over the exposed subgrade by means of the blade grader, but in this operation a separator attachment is placed ahead of the blade, this attachment consisting of two rows of spring steel teeth set staggered on a steel frame suspended from the circle of the grader. These teeth penetrate about 1½ to 2 inches into the surface of the ridges and bring to the surface the stones immediately under it so that the blade pushes the stones forward and they roll to the bottom, smaller stones following in direct proportion to their size and weight. As this process continues the two ridges gradually meet at the center in such a way as to give a uniform depth of gravel over the road, the final operation including bringing all the material, including any that may have been left at the sides, into a center ridge, the base of which covers the part of the subgrade that was left exposed when the two ridges were formed.

The process is then repeated in the opposite direction, this center ridge being spread toward the outside, the teeth of the separator bringing to the surface the remaining large stones and permitting them to roll into position on the subgrade.

It is said that when this work is properly done, there results a smooth, uniform gravel surface of maximum density throughout the entire mass. The wear of the road will develop no soft spots or sand pockets because of nonuniformity of material, while the foundation of heavy stones adds to the durability of the road in the same way that a Telford base does to a macadam road. It requires 2½ to 3 days with the grader and tractor for treating a mile of road in this way.

The same process has been used in reconstructing old gravel roads, the roads first being scarified and the gravel scraped into a central ridge. In one case where stones as large as 6 inches were found in the old gravel road, satisfactory results were obtained. It is claimed by Mr. O'Neil that the cost of a gravel road made in this way is even less than a good gravel road made in the ordinary way, since such a road generally requires the screening of the gravel or even putting the coarser stones through a crusher, neither of which is required in constructing the roads in this way.



BEGINNING DIVISION OF GRAVEL INTO TWO LONGITUDINAL RIDGES
WORKING LONGITUDINAL RIDGES TO SIDES OF ROAD
SPREADING SIDE RIDGES TOWARD CENTER
CENTER RIDGE REFORMED

Utah's Road Problem

Some of the Western States have problems of road financing that can hardly be appreciated by the Eastern States. In Utah, for instance, according to a statement by William Peterson, former state road commissioner and now director of the Experimental Station, only 3% of the land in the state is being farmed and only 18% is privately owned, and yet roads are demanded leading to all parts of the state. The state now has invested in its roads bonds alone amounting to more than $16,000,000 or 2½% of the total valuation of the state.

Mr. Peterson states that money spent in roads depreciates faster than any other form of legitimate expenditure. Investment in an earth road may be absolutely obliterated within five years unless the road be properly maintained. He estimates that the state will have to spend $500,000 a year to protect its present investment in roads of about $18,000,000.

Toll System for State Highways

A proposition was introduced in the South Carolina Legislature for raising funds for highways in that state by charging a toll of 1c. a mile for all passenger vehicles and 2c. for other vehicles. Representative Harper, who introduced it, claims that the amount of the toll would be saved to automobile owners in the cost of gasoline in that "it costs $1.74 per hundred ton-miles to operate on dirt roads and only 71c. per hundred ton-miles on hard surface roads."

It was proposed to issue $40,000,000 of 4½% twenty-year bonds. It was estimated that toll keepers would cost $250,000 a year, giving the total amount to be raised in twenty years as $81,000,000. (Nothing is said about cost of maintenance and repairs.) For income, it is estimated that there would be 100,000 cars and trucks averaging 10 miles a day. Deducting from the annual income, the interest and cost of gate keepers would leave $1,550,000 a year. The total for the twenty years plus 4% interest on the accumulations would give $47,000,000. It is estimated that the number of cars used would increase 5% each year, which would add a total of $49,000,000 to the receipts, giving a total over and above annual expenses of $96,000,000, leaving $56,000,000 after paying off the bonds. It is assumed that at the end of twenty years roads would still have a value at least one-quarter their construction cost.

We have not attempted to figure out just what the effect on the financial statement would be if we allow for the necessary expenditure for maintenance and repairs. Some highway engineers also might question whether there would be even one-quarter the original value of the road left at the end of twenty years.

This idea was presented as an amendment to a bill providing for submitting to the voters the proposition to raise $60,000,000 for highways by bond issue, which was turned down by the Legislature, and it is not probable that the toll road or any other system of raising either $40,000,000 or $60,000,000 for road purposes will come up again at this session.

Atlantic Coast Highway

The South Atlantic Coastal Highway Association held a meeting at Charleston, S. C., on March 15th, at which representatives were present from North Carolina, South Carolina, Georgia and Florida. The association announces that a federal highway from Washington, D. C., via Richmond, Norfolk, Wilmington, Charleston, Savannah, Brunswick and Jacksonville to Miami, hugging the coast from Norfolk to Miami, will probably be a reality by the winter of 1924, "with permanent bridges crossing the streams and rivers between the points mentioned." The association has been working on this project for several years.

New Jersey Highway Work

The State Highway Department of New Jersey reports that, while the 1922 road program provided for the construction of 128.9 miles of highway, the embargo on open top freight cars, delay in obtaining materials, etc., confined the actual construction to 69.3 miles of durable pavement, 3.7 miles of 6-foot shoulders of bituminous concrete and 5.9 miles of completed gravel road, while 50.4 miles were more than 50% completed at the end of the season.

The report states that "while the policy of the department is to construct only hard surface pavements of durable type, it sometimes is necessary to grade and lay a temporary pavement a year or two prior to the construction of the permanent pavement. This is a necessary precaution pending the final settlement of the fills. During the past year 8.8 miles of state highway were thus graded and surfaced with gravel."

The state highway system contains 725.8 miles of road and when the 1922 program is completed 302 miles will be paved with hard surface pavement and of the remainder a considerable amount of bituminous concrete in good condition, but not laid on a rigid foundation.

Gravel Roads in Nevada

Give least annual cost where traffic does not exceed 400 vehicles a day. Recent changes in construction methods.

Nevada has used, in surfacing its roads, gravel, cement concrete, asphalt concrete and asphalt macadam. Up to the first of this year it had completed 154 miles of gravel road, 35¼ miles of cement concrete, 1½ of asphalt concrete, and 3½ of asphalt macadam. Gravel roads therefore greatly exceed in mileage all other kinds combined. The reason for this is explained as follows by Howard M. Log, assistant state highway engineer:

When material is available locally, the cheapest surface to construct is one of gravel. Such a surface, when properly constructed, can be maintained economically and as cheaply as surfaces of higher types provided the traffic does not exceed about 400 vehicles per day.

The contract cost per square yard for gravel surface on eighteen projects contracted in 1922 varied from 29 cents to 85 cents, the wide variation being due principally to the difference in length of haul for the material and the ease or difficulty with which it could be secured from the pit. On four contracts the cost was more than 60 cents per sq. yd., on two less than 40 cents per sq. yd., on eight between 40 and 50 cents and on four between 50 and 60 cents per sq. yd. The average contract cost for all projects was 50 cents per sq. yd.

The approximate cost of other types of surface are as follows:

Asphalt macadam, 6 inches thick, $2.00 per sq. yd.

Asphalt concrete, 6 inches thick, $2.75 per sq. yd.

Portland cement concrete, 6 inches thick, $2.85 per sq. yd.

It is apparent from these figures that, unless

gravel cannot be secured within a reasonable distance of the project or a large traffic is anticipated in the near future, the economical surface to construct is one of gravel. Furthermore, a large part of the state highway system lies in territory where it would be impracticable to construct a "hard surface" without first building a gravel or rock sub-base which would add approximately the cost of a gravel surface to the above costs for higher types. This condition prevails in nearly all of the valley bottoms, such as the Humboldt and Reese river valleys. This same soil is inadequate to carry the traffic that now uses the roads and therefore a surface of some kind must be provided at the time the grading is done. A good gravel surface constructed at this time becomes the base for a higher type surface in the future when the increased traffic requires such a surface.

Surfaces of mine waste, decomposed granite, shale, or crushed rock are considered as included under the heading of gravel surface. Although the cost of a crushed rock surface will usually be more than one of gravel, in some cases ledge or float rock may occur in the vicinity of the project while gravel could be secured only by an almost prohibitory haul.

Prior to 1921, gravel surfaces were constructed of material grading downward from a maximum size of 2½ inches. This size was used because it fitted the available deposits in the State and also conformed to standard practice in other parts of the country. It was found that the larger particles in a surface so constructed continually worked to the surface and were then torn loose, causing the formation of holes and adding greatly to the cost of maintenance. Consequently, the maximum size of the material used has been reduced to 1 inch and the grading and proportioning is being carefully watched so as to secure a uniform material. We note that other states are reducing the maximum size of their material evidently for the same reasons.

It has been satisfactorily demonstrated by this year's construction that the use of a 1 inch maximum size gravel is giving a surface which compacts and binds much better and on which the maintenance will be much less than on the surfaces using a larger material.

It is evident that a much larger percentage of the pit or deposit must be rejected when the maximum size allowed is 1 inch instead of 2½ inches and yet the average cost per square yard for gravel surface was actually less is 1922 than in 1920. This is due to lower costs for labor and materials and to the fact that the contracts were awarded this year on the cubic yard and yard mile haul basis. That is, the contractor receives a definite price for each mile over which a cubic yard of gravel is hauled in carrying it from the pit to the road. Under the specifications previously used, the contractor bid a price per square yard for the surface complete in place regardless of the haul. He naturally increased his bid to cover the contingency of an unanticipated increase in the haul distance and the State paid the increased price whether or not there was an increased haul.

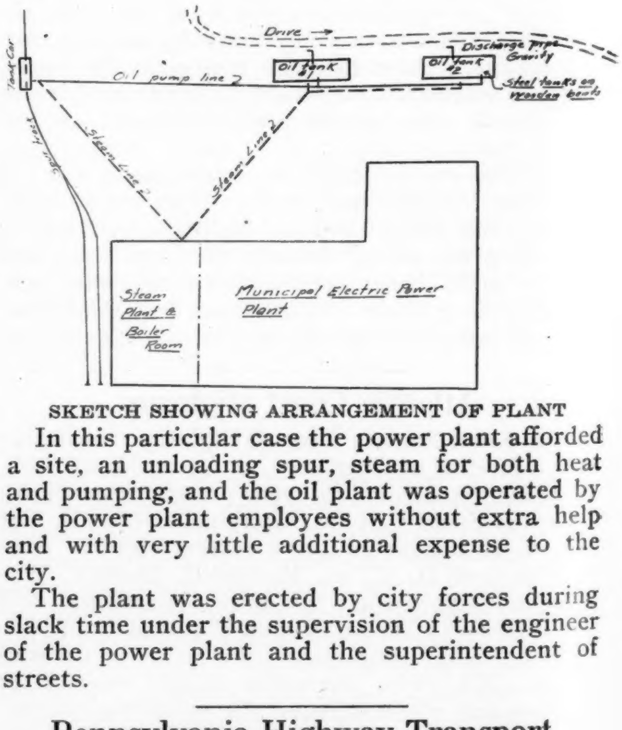
Our effort to remove some of the gamble in highway contracting has borne fruit in dollars saved to the State.

Oil Plant Combined with Power Plant

By O. H. Hampsch

A western Kentucky city of which the writer was an assistant engineer, having decided to establish a municipal oil plant for street oiling, found that it would be of considerable advantage to operate this plant in connection with the municipal electric power plant.

There was available space adjoining this plant which was utilized for the location of the tanks, which were erected here on creosoted wooden bents so situated as to be near the spur track and steam lines of the power plant. This permitted oil in the tank cars to be heated by a steam line from the power plant and the oil to be pumped into the storage tanks. Before the oil was drawn from these tanks it was heated by a steam line from the plant and the pressure was regulated from that point. The tanks were elevated so that the distributors were loaded by gravity from them.



SKETCH SHOWING ARRANGEMENT OF PLANT

In this particular case the power plant afforded a site, an unloading spur, steam for both heat and pumping, and the oil plant was operated by the power plant employees without extra help and with very little additional expense to the city.

The plant was erected by city forces during slack time under the supervision of the engineer of the power plant and the superintendent of streets.

Pennsylvania Highway Transport Survey

The Pennsylvania State Highway Department is planning a highway transport survey as the only accurate basis for estimating the traffic needs of the various roads. This is following out the recommendation of William H. Connell, the assistant highway commissioner, made in his

report last summer for Governor Pinchot. In this he recommended a traffic census taken during the winter, summer, spring and fall seasons on the main or proposed routes and their feeders; a study of the probable future traffic based o information relative to the population, agricultural districts, industries, resorts, etc., to be served by the roads when improved; and a study of the cost of operation of vehicular traffic under different conditions of line or grade. "From this information the economics of the different pavement types for different sections of the highway routes can be intelligently discussed and decisions made on the basis of fitting the types of pavement to the requirements."

Present traffic, he said, is very little indication of what burden will be imposed upon a highway 20 or 30 years from now. What that will be will depend upon the considerations above referred to, but there must also be taken into consideration traffic across the state which will be independent of local conditions, but will be determined by the relation of this road to the routes of interstate traffic.

The Lincoln Highway in 1922

The work accomplished on the Lincoln Highway during the year 1922 is reported by the Lincoln Highway Association as totalling about 243½ miles in the eleven states through which it passes, the cost of new construction having been $4,678,042 and $1,368,126 having been spent on maintenance.

The nature of the new construction varied considerably as well as the cost per mile. In mileage Nebraska leads with 69.6 miles at about $7,500 per mile, while New Jersey leads in the cost of new construction with $1,160,824 for 5.61 miles, or at the rate of nearly $207,000 per mile. Utah alone spent nothing on new construction and its expenditure for maintenance is estimated at only $5,000.

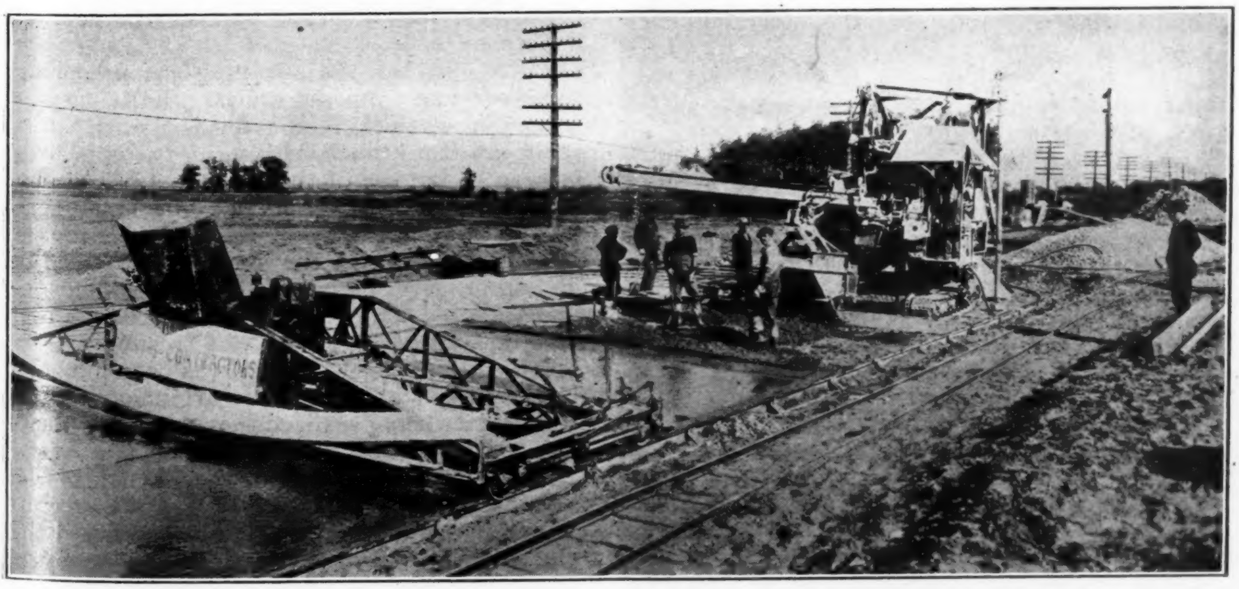
The amount of the different types of pavement completed on the Lincoln Highway last year were as follows: Gravel, 144 miles; concrete, 56.91 miles; brick, 15.13 miles; permanent earth grade, 27.40 miles.

Since 1913, when the highway was first laid out as a transcontinental route, about $47,000,000 has been spent in constructing 3,305 miles. Of this total distance 1,189 is graded gravel and 62 is natural gravel, 578.7 is concrete, 327.8 is bituminous macadam, 287.1 is waterbound macadam, 128.8 is brick, 218.5 is composed of paved city streets and the remaining 513 miles is in earth roads, mostly graded but about 109 miles are still in natural earth.

PAVING IDEAL SECTION

In the January issue of Public Works we gave some information concerning the construction of the so-called "Ideal Section" of the Lincoln Highway. Since then we have received, through the courtesy of the Lincoln Highway Association, some photographs showing work on construction of the concrete pavement of this section.

As stated in the previous description, the pavement was laid in two strips each 20 feet wide. These strips were finished separately by the contractor. The first was finished in the usual way, but in finishing the second strip the contractor fitted the Lakewood finishing machine with a special set of wheels on the end next to the completed pavement, which had a flat tread and travelled on the concrete, while the wheels on the other end which travelled on the side form were double flanged so as to prevent side motion in either direction. The results obtained were considered very satisfactory.



LAYING SECOND LONGITUDINAL STRIP OF "IDEAL SECTION," LINCOLN HIGHWAY

A Hill Road As an Asset

Ordinarily a hill in the line of a highway is considered objectionable, but an instance was recently learned of where, although the highway engineer reported in favor of going around the hill because this would save cost of construction and of maintenance and eliminate an eight per cent. grade, the citizens have petitioned the county commissioners to continue the road over the hill, where it now runs. The hill in question is in Dade County, Florida, a section of the country where hills are so infrequent that even the difficulty of climbing is considered to be more than offset by the "pleasant surprise to people coming by this route who thought Florida nothing but low, flat lands."

Gasoline Tax in Several States

General approval of it by the public, the arguments that led eleven of the states to adopt it, and methods of collection.

The Department of Highways of Nevada, during the latter part of 1922, while studying the question of raising state highway funds by taxing gasoline, obtained opinions of the highway officials of several states that had already adopted this plan, which it summarizes as follows:

GENERAL ATTITUDE OF THE PUBLIC

ARIZONA—"We believe that the one-cent gasoline tax levied by the State of Arizona has worked out very well and that there is no general complaint in regard to it."

ARKANSAS—"The present attitude of the public towards this tax is one of approval."

COLORADO—"The present attitude of the public is very decidedly in favor of it."

CONNECTICUT — "Naturally some adverse criticism has been made in this matter. The general public, however, has no complaint to make, the amount of the tax for a year being comparatively small for the average car user."

KENTUCKY—"On the whole it appears that the citizens of the State have recognized the justness of the gasoline tax."

MARYLAND—"There is enthusiastic and universal approval of the gas tax by the public. In fact, the legislation was passed at the last session of the Assembly without a roll call in either House or Senate. Since its advocacy before the legislature, we have not heard a single objection to it by anyone."

MISSISSIPPI—"We believe that this bill has the approval of the people."

NORTH CAROLINA—"There seems to have been no objection whatever by the public to this tax."

PENNSYLVANIA—"Strange as it may appear, little or no protest was made against the passage of this act."

SOUTH CAROLINA—"There is general approval of a tax on sales of gasoline."

SOUTH DAKOTA—"There seems to be but very little complaint on the part of the public towards paying the tax."

WASHINGTON—"The public apparently favors this tax."

ARGUMENTS WHICH LED TO ADOPTION OF TAX

ARIZONA—"In this State the tax on gasoline has proved a very satisfactory means of raising money for road purposes. In our opinion the gasoline tax will shortly be nearly universal, and that State lines will not interfere with its operation."

ARKANSAS—"The principal argument for the adoption of the gasoline tax is the fact that this tax is the most equitable one that can be devised to force the users of our roads to bear a part of the cost."

COLORADO—"The necessity of roads and the fact that it is paid by those directly interested in better road facilities."

CONNECTICUT—"The adoption of the tax was due largely to the need for increased revenues. It has also been argued that this tax is more equitable for motor vehicle users inasmuch as it is directly proportionate to the use of the road and the weight of the vehicle."

KENTUCKY—"Gasoline tax was adopted in Kentucky for the reason that the large part of it was consumed in automobiles, which were believed to be the most destructive agents of our limestone highways. The idea was to place the cost of construction, reconstruction and maintenance on those who are actually wearing out the highways."

MARYLAND—"In the little State of Maryland we are collecting about $2,500,000 from motor vehicles in direct taxes, and it certainly has become a real business, and should be treated in a business way. By this we mean that every user of the road should pay for the service which he receives, no more, no less."

MISSISSIPPI—"The biggest argument used in favor of this tax in this State was that inasmuch as the automobile is the most destructive agent of the roads, the automobile owners should pay a larger part of the cost of maintenance."

OREGON—"It has the advantage of procuring some revenue from the tourist who is exempt from motor vehicle fees, and it is also an equitable tax from the fact that the tax is in proportion to the use of the roads."

SOUTH CAROLINA—"The tax on gasoline was imposed by the Legislature at its session in 1922 in response to the demand that the tax on real property be lessened and that the users of gasoline contribute to the construction and maintenance of the roads."

SOUTH DAKOTA—"The law was passed by the Legislature with very little argument on account of its being realized that the tax is equitable."

WASHINGTON—"It was urged in behalf of the tax that it placed the burden of highway construction upon those who primarily derived the chief benefit from the existence of highways."

METHODS OF COLLECTION

ARIZONA—"The tax is made at the wholesalers, which means that the cost of collection is very small."

COLORADO—"We collect the tax from the wholesalers shipping in bulk. The attempt to collect from retailers would be an expense and not effective."

MARYLAND—"Our gasoline tax is collected from the importer or refiner, before it is offered for sale in this State. By this method we have only about twenty 'dealers' in the State, and the question of collection is greatly simplified. This method has given eminent satisfaction, and there seems to be no objections whatever to it, and really, there seems to be no other logical place at which the tax can be collected. If, as in one or two States, it is collected by the State from the filling stations, the general seller to the ultimate consumer, your dealers run into the thousands with the attendant extra expense because of the smaller quantities sold, and the attendant loss from the percentage of dishonest dealers."

Conclusions from the Pittsburg Test Road

Tentative conclusions from latest tests show importance of sub-grade conditions, strength of thin slabs, and the importance of absolute smoothness and thickened edges.

The construction of a test road at Pittsburg, California, and some of the results obtained have been described in PUBLIC WORKS for October 29th and December 10th, 1921, and for January 14th and February 11th and 18th, 1922. Results of tests made subsequently will be published in detail in the near future by the U. S. Bureau of Public roads and the California State Highway Commission. In the meantime, tentative conclusions derived from these statistics have been made public by T. E. Stanton, assistant state highway engineer of California, in a paper before the American Association of State Highway Engineers. In the following abstract of this paper we have endeavored to give briefly the more important points presented by Mr. Stanton:

"One of the most astonishing results of the Pittsburg test was the ability of the thin slabs, even the 5-inch, to withstand severe punishment..

"This was undoubtedly due to a very large extent to the care with which the subgrade was constructed and any discussion of design must therefore take into consideration specifications for subgrade treatment as well as the design of the pavement section.

"The outstanding determinations may be summarized as follows:

"1. Thorough and proper subgrade treatment is the first prerequisite of success in pavement construction.

"2. Assuming proper subgrade preparation even the 5-inch slab will stand up under a large volume of truck traffic without serious deterioration.

"3. The thickened edge increases the strength of the thin slab to a very considerable extent and can be economically justified, especially from a maintenance standpoint.

"4. Absolute smoothness, especially at joints, is essential if the pavement is to withstand the hammering of solid tired trucks.

"It may be said that the above determinations add little to our previous knowledge as for some time highway engineers have known that proper subgrade treatment and care in the finish were essential factors in the success of any pavement and especially of the thin slab; also, that the thickened edge is a decided advantage.

"The extent of the part which these factors play in the successful design, construction and maintenance of concrete highways has, however, been forcibly brought to attention as a result of the above tests."

PREPARATION OF SUBGRADE

This pavement test was inaugurated by the Columbia Steel Company with a view to developing a market for a special high-grade steel used as reinforcement. The thirteen sections selected for investigation were suggested by federal, state and county highway engineers. The first series of tests made by this company was completed in January, 1922, and a second series was started in June by the U. S. Bureau of Public Roads and the California Highway Commission, these tests continuing through July and a part of August.

In the construction of this road special pains were taken with the subgrade. The road was built on black adobe soil, and in order to secure conditions as nearly uniform as possible the site of the road was levelled off to a grade three feet below the finished subgrade and then built up to a height of three feet by layers of earth spread nine inches thick, loose measurement, thoroughly harrowed and pulverized and then compacted with a 12-ton roller to about six inches thickness; each compacted layer being scarified to a depth of two inches before application of the succeeding layer. After the completion of this embankment, header boards were set true to line and grade and the material between them was scarified to a depth of six inches by a subgrade machine and the excess dirt removed to approximately 1½ inches above subgrade. The subgrade was well scarified to a depth of two inches, water sprayed on and then rolled. While still moist, the subgrade was dressed off with the subgrade machine to the correct elevation, following which it was sprinkled lightly each day until the pavement had been laid, to prevent cracks forming in the soil.

DESIGN OF PAVEMENT

California had built many miles of five-inch concrete pavement and also a considerable extent of four-inch pavement which was then and is still giv-

ing service after ten years' use. It was therefore decided to test thin concrete slabs in this road. Among other sections was one known as the "Arizona type" which had a uniform thickness of six inches except for two feet from the edge, which gradually increased from six inches to nine inches at the edge. (This is apparently the same section that was last year adopted by the Illinois State Highway Department.) The idea of thickening the edges of concrete pavement was by no means new. About 1910 the Highway Commission of Wayne County, Michigan, constructed "inverted curbs" or beams along the edges of their pavements. This was later concluded to be a mistake in that the moisture apparently was held under the pavement by the curb and, in freezing, broke the curb from the body of the pavement. California in 1912 adopted a thickened edge as an alternate type, the curb or beam being wedge shape. Both the Arizona type and the inverted curb type, and thicknesses varying from five to eight inches, were included in this test road.

TESTS MADE

During the first test ending January 28, 1922, 3,672,730 tons passed over each section of the road and none of them had completely failed, although it was found necessary to make rather extensive repairs on portions of the five-inch slab. During the second series, conducted by the U. S. Bureau of Public Roads and the California Highway Commission, 3,690,000 tons passed over the road. In this test the minimum gross load used was 14,500 lbs. while the maximum ordinary gross load was 27,000 lbs. and the average was approximately 24,000.

At the conclusion of this test the pavement had not failed sufficiently and it was desired to make a further test to determine the tonnage required to cause complete failure of the different sections. Accordingly, a super test was carried on for seven days. In this a two-wheel trailer carrying a load of approximately 16 tons made 105 circuits and a few places were shattered on the 5-inch sections. The trailer was then loaded to approximately 30½ tons and there was a general shattering of the 5-inch sections under the rear wheels in many places, except that one 5-inch section that was reinforced top and bottom was not seriously affected. The trailer was then loaded to 50 tons and cut entirely through a 5-inch section and stuck there. It was then unloaded to 35 tons and made three circuits, which resulted in a continuation of the shattering of the 5-inch sections, but the other sections were not appreciably affected. The load was then increased to 40 tons and the two circuits made, during which the shattering of the five-inch sections continued. It was then loaded again to 50 tons and three circuits were made, the rear wheels cutting two furrows almost entirely through all but one of the five-inch sections, the one reinforced top and bottom being cracked only slightly and showing only very little shattering. Two sections 6 inches thick and reinforced top and bottom were shattered very little. A six-inch section with thickened edges but not reinforced was almost unaffected. Except one 5-inch section, all sections that carried inverted curbs and no reinforcement were practically unaffected. The trailer carrying the 50-ton load was equipped with dual 5-inch steel tires and on all of the slabs slight abrasion of the surface was noted.

CONCLUSIONS

The first set of tests, which ended in January, 1922, was of medium to heavy traffic on solid tires and is estimated to have been equivalent to similar average traffic over the California State Highway system of from 25 to 40 years. This is based on traffic census of California highways taken by the Bureau of Public Roads. The bulk of the traffic so enumerated was of course on pneumatic tires and the results at Pittsburg indicated that any amount of this kind of traffic does a relatively small amount of damage to such pavements.

Said Mr. Stanton: "Where a 5-inch base with edges thickened to 7 or 8 inches will carry all the traffic which can reasonably be expected for a period of twenty-five to forty years without excessive injury, the construction of a 6-inch slab with 9-inch edges is of questionable economy; especially in view of the fact that in the event of an unexpected increase of damaging traffic on a part or all of a section, an asphalt surface can always be added." In California, where the subgrade conditions are bad either the subgrade is treated or the pavement is made not less than 6 inches thick or both; but where the traffic is comparatively light and subgrade conditions satisfactory, a 5-inch base with 7-inch thickened edge is being constructed. A study of bids received for constructing concrete pavements in California appears to indicate that contractors there bid practically as much a cubic yard for a concrete pavement six inches thick as for one five inches thick.

One important conclusion from these tests resulted from the observation that "all the failures originated at points where slight inequalities in the pavement occurred, and extended rapidly around the fractured area if they were not promptly repaired. In general, it may be stated that with a rigid type of pavement such as the Portland Cement concrete type, absolute smoothness of surface is an essential requisite."

Standard Specifications for Missouri Highways

The State Highway Commission of Missouri has issued new standard specifications governing state road and bridge construction which supersede those issued in May, 1919. Instead of furnishing a copy of these specifications with each contract or for each job on which bids are invited, copies have been sent by B. H. Piepmeier, chief engineer of the Commission, to contractors, equipment companies and other interested parties with the request that they keep them in their files for future reference. In the future the Department will furnish to prospective bidders the special provisions that are bound in the proposal form but not the standard specifications. This is expected to result in considerable economy in the publication and mailing of specifications to the numerous bidders on state highway work.

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A. PRESCOTT FOLWELL, Editor

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Adequate Maintenance or No Construction

"Unless adequate maintenance is provided for, initial construction of highways should not be undertaken at all." This unqualified assertion of a committee comprising nine of the most prominent state highway commissioners and engineers of the country, assembled in Harrisburg last month, is perhaps the most important sentence in that committee's summary of the conclusions of the Harrisburg conference.

This idea is emphasized by the Bureau of Public Roads in its regulations for the allotment of Federal aid, whereby a state is required to provide adequate maintenance of all F. A. roads. Because of failure to do so and to maintain an adequate highway department, Arkansas has been denied Federal aid this year, and very properly so.

A road begins to depreciate by the end of its first season. If the road is properly maintained, the depreciation can be kept at a fairly uniform and moderate amount each year; but if it is not, the rate of depreciation increases rapidly and practical destruction is sure.

The country has invested several thousand million dollars in improving its roads, and is increasing this at the rate of nearly a billion dollars a year. Part of this is permanent improvement —grading, bridges, etc.; but, perhaps half is subject to rapid depreciation and if adequate maintenance is not provided will be totally lost within five or ten years, while meantime an increasing percentage of the investment fails to give adequate return in the shape of benefits to traffic.

If only a fixed amount is available for highway purposes for several years to come, this should be so apportioned by the wise judgment of a highway expert that each year will find available for maintenance an amount sufficient for the proper upkeep of all the roads that have been improved up to that year; due allowance being made for the increase in traffc that will certainly follow the improvement.

Dirt Roads

There are more than two million miles of roads in the United States that are just dirt roads—not even a gravel or sand-clay surface. Some of these are on trans-continental routes, many are on interstate routes, but most are little-traveled country roads. Although the mileage of improved roads is but a fraction of that of dirt ones, the ton-mile and even vehicle-mile traffic is undoubtedly much greater and the improved roads do and should have more public funds spent on them than the dirt roads.

But this does not mean that the dirt roads should be neglected and the taxpayers who must use them receive no consideration. If the improved roads average 500 vehicles per day over each mile and average $3,000 a year for maintenance and depreciation, while dirt roads average 5 vehicles a day, equal consideration would call for $30 per mile per year for maintenance—not much, but $30 more than the greater part of them receive.

More attention should be paid to the improving of dirt roads, by shaping, planing, and inexpensive surfacing with gravel or other local material. We believe that if engineers turn their attention seriously to this problem it will be found that great improvement can be obtained at moderate cost. An encouraging indication is the annuncement that the Department of Civil Engineering of the University of Illinois is conducting experiments and an investigation of this subject. A report of results has recently been made, which we expect to abstract in an early issue.

Morals of Municipal Contracting

Under the above title the official publication of the Contractors' Association of Philadelphia, has published an editorial calling attention to the injustice and one-sidedness of the contracts under which contractors are required to do work for the city of Philadelphia. The chief point of complaint is that the contract makes the engineer the arbitrator in misunderstandings between the contractor and the city, stating that "the contract is fundamentally unfair, and further is intentionally unfair in that the whole effort is to prevent the contractor from asserting any right that he has, and intentionally unfair in attempting to compel him to adopt constructions and decisions made by the other party to the contract, whose interest is adverse."

As a remedy, the organ of the Contractors' Association suggests that a city ordinance be adopted requiring the contract to give the contractor the right to appeal from the decision of the city engineers if he feels he has been aggrieved; this appeal to be settled either by arbitration or by the courts. "This would not in any way interfere with the progress of the work because such specification could provide that until the work was completed the contractor would be absolutely bound by the orders of the city, but if such orders required him to do more than his contract, then the city would have to pay the extra cost of the work which the contractor has been required to do."

Correspondence Course in Drafting

The National Vigilance Committee of the Associated Advertising Clubs of the World calls attention to the advertisements of Chief Draftsman Dobe "as being misleading" and the American Association of Engineers is warning its members against his advertisements. The Vigilance Committee reports that, according to these advertisements, "a 15-year-old boy with ability to read, write, use figures and follow instructions, can study under Dobe for the equivalent of three to six weeks of solid 8-hour days and then be prepared to earn, and in fact is guaranteed, a salary of $250 to $300 a month with $450 on the side at home. A magnificent set of drafting tools are advertised free as an inducement to prospective students. However, the approximate sum of $65 is charged for the course and must be paid before the free tools become the student's property."

Of course, no one at all familiar with engineering would place any confidence in these statements, but a great many young men must be misled, for these advertisements have appeared for a number of years, one in Popular Mechanics magazine consisting of two full pages costing $1,150 per issue on a yearly contract basis. The National Vigilance Committee was assisted in collecting the data for its report by a committee for the Chicago chapter of the A.A.E. consisting of W. A. Artingstall, Paul Hansen and Robert W. Shelmire.

Engineering Positions in Civil Service

Advantages offered, positions open and salaries paid. Statement of Civil Service Commission.

The U. S. Civil Service Commission a few weeks ago made public for general information a letter addressed to Prof. J. C. L. Fish, of the Department of Civil Engineering of Stanford University, giving, in reply to his inquiry, very complete information concerning civil engineering positions in the servicie of the Federal Government.

Data compiled by the commission show that there are approximately 2,000 civil engineering positions in the Federal Civil Service. These are in various departments and bureaus, and the designations of the positions are by no means uniform in the several departments. The list of civil engineering employees shows 636 in the War Department, 9 in the Treasury, 446 in the Interior, 125 with the Interstate Commerce Commission, 396 in the Department of Agriculture, 106 in the Commerce Department, 22 in the Navy Department and 24 in the Postoffice Department.

In the Navy Department the salary ranges from $6.72 a day to $14.16 a day; in the Department of the Interior the salaries are by the month, ranging from $100 to $300. In all the other departments the salaries are by the year and range from $1,000 for topographic draftsman in the Interior Department to $9,000 for civil engineer with the Interstate Commerce Commission.

The letter states that vacancies are constantly occurring in the Federal Civil Service and there is never a time when there are not openings for civil engineers. Special attention is called to the positions of junior engineer and deck officer under the U. S. Coast and Geodetic Survey, there being practically always a shortage of eligibles for these positions, although the entrance salary is $2,000 and the position can be obtained immediately upon graduation from an engineering school. In explanation, it is found in the requirements for these positions that the applicant must have been in the upper half of his class in each of the major subjects on which his selection is based, for his entire collegiate course. Men who cannot meet this requirement are not even considered. Moreover, he must obtain an "A" standard in physical examination.

Concerning the advantages claimed for Government employment for civil engineers, the Civil Service Commission mentions the following:

"The Government service offers a wide field

where individual tastes may be developed and where real constructive work—big interesting, clean work—may be done. Probably it cannot be said that under present conditions employment in engineering positions under the Government is as lucrative as the same employment in private industry. Nevertheless, the civil service has much to commend it.

"Not the least of the advantages of Government employment is to be found in the opportunity it affords for useful public service. Further, it increases one's scientific knowledge and training through contact with a large number of highly trained men. The experience gained by a young engineer in Government work might be classed as a post-graduate course. The opportunity to meet and profit by the experience of engineers who stand high in their profession is excellent, both in the field service and in Washington. The assignment to different fields, which are often possible for the young engineer, add to his education, for they bring him in close touch with many phases of engineering work and acquaint him with local conditions as they apply to various engineering problems. This opportunity for travel and study is one of the greatest inducements for entering upon Government work.

"Advancement in the service depends upon the degree of ability displayed and, of course, upon the needs of the service. It is assured that ability will be recognized by advancement in grade and salary wherever possible.

"Aside from advancement within the service, many recent graduates enter the Government service because of the well-founded belief that a few years of experience in Government work will be of material aid in securing good positions in the industries.

"Less important advantages of Government work are the thirty days' annual vacation leave, thirty days' sick leave in meritorious cases, retirement with annuity, and benefits under employees' compensation acts in case of injury incurred in the performance of duty. It may further be said that Government employment offers a better prospect of steady work than does private employment generally."

Applications for the position described above as "junior engineer and deck officer" will be received until June 30th of this year. Other openings at the present time are for positions with the Bureau of Standards of engineer at $2,800 to $4,000 a year; associate engineer, $2,000 to $2,800 a year, and assistant engineer, $1,500 to $1,800 a year; applications received until further notice. Also, with the Interstate Commerce Commission, junior engineers at $1,320 to $1,980; applications received until further notice. Also copyist topographic draftsman at salaries ranging from $1,140 to $1,640 a year; applications received until further notice.

Vigo County's Experience with Vibrolithic

Probably many of the readers of PUBLIC WORKS know little about the kind of concrete pavement called vibrolithic, and on learning that Vigo County, Indiana, had laid considerable of it and epected to lay ten miles more this year, we asked Mr. Gibbons to describe his experience with it. In response he has sent the following letter:

PUBLIC WORKS,

Gentlemen:

We are contemplating the construction of approximately ten miles of Vibrolithic concrete pavement in this county, during the coming Summer. We have at present let four miles, the bid price per square yard being $2.09, which is much lower than the State Highway Commission is getting upon their plain cement concrete pavements which they have let so far this season, their prices per square yard ranging from $2.42 to $2.60, and this is practically the same thickness of slab that we have.

This county constructed, in 1918, one and one-half miles of Vibrolithic for $2.65 per square yard, in 1919 about the same mileage for $2.76 per square yard, in 1920 and 1921 we completed about 14 miles, the cost being from $2.69 to $2.94 per square yard. These pavements are all in good condition—some cracks of course, but nothing serious. We keep them poured, or rather the contractors do, as we have a five-year guarantee upon all of this construction. It is impossible with this form of construction to get quite so smooth a wearing surface as with the plain cement concrete pavements, but these pavements are wearing much smoother every day, and from appearances and reports, they are so far getting into better shape each day.

The Vibrolithic process really means nothing more than a well tamped concrete. In all this construction, any one can walk upon the slab immediately after the vibrator has passed over, without going into the concrete any deeper than the cement float, that is very seldom over the thickness of the shoe soles; so from that you can get some idea of how the concrete has been compacted by vibration. We have had a great many tests made privately at Purdue University, with plain slabs, and with vibrated slabs with and without the top coating of gyranite, trap or boulders, and at all times the vibrated specimens were much superior to the others. R. C. Yoeman, secretary and engineer of the Indiana Gravel Producers' Association at Indianapolis, Indiana, conducted most of these tests while he was connected with the College of Engineering at Purdue University.

All our specifications covering Vibrolithic pavements have been approved by the Indiana State Highway Commission. We build the slab six inches thick and 18 feet wide with a two-inch crown. The concrete slab is composed of plant-mixed gravel, carrying from 65 to 70 per cent. of gravel ranging from 1/8 inch to 2 inches in diameter, the sand being below 1/8 inch in diameter. By being able to use the plant-mixed material in this process, we save quite a sum of money for gravel and sand over the prices that we would have to pay for the separate aggregates; also our cement content for a cubic yard of concrete is 1.30 barrels, this also makes a saving in cement. However, we vibrate a layer of granite, trap or crushed boulders in or over the top of the green concrete to the amount of sixty-three pounds per square yard or about one and one-half inches in depth, this makes in all about seven and one-half inches in depth of materials used, and the slab is compacted or vibrated to a finished thickness of six inches.

We put in expansion joints about every thirty-three feet, cutting through the top three inches only, allowing the slab to crack underneath. The joint is filled with a prepared asphaltic material and vibrated into place, thus practically sealing the joint.

Our Vibrolithic pavements at present range from nearly five years to one year in age, and I can truthfully say that the older pavements are better in every way than the newer ones, and are still getting smoother. The mortar float finish is wearing off and the traffic is now rolling upon the granite wearing surface and smoothing up nicely; in fact, I am very much pleased with the result, and would indorse this type of pavement anywhere and at any time. I believe in it.

Yours truly,
ROBT. E. GIBBONS,
Vigo County Engineer,
Terre Haute, Indiana.

Abuse of Separate Sewers and Storm Drains*

Suggested remedies include care in selecting system, zoning, municipal construction of connections, and co-operation between municipal departments.

Great care should be exercised in the selection of the type of sewer system to be installed. It should not be assumed that separate sewers are more advantageous, but conclusion should be reached only after careful study of all the conditions, including comparative estimates of cost. In making such studies due weight should be given to the value of the opportunity for disposal of roof water into sewers and to the inequity of affording such facilities to a portion of the property owners and withholding them from others. It may be accepted as a fact that residents will not tolerate standing water in their cellars. In thickly settled communities water cannot be allowed to flow over sidewalks to the street gutters, and, at least in the northern portion of the country, roofs and areas cannot satisfactorily be drained into gutters by pipes passing under sidewalks. Topography, character of soil, climate, present and prospective density of population, frequency and intensity of precipitation, as well as conditions influencing the problem of sewage disposal, are among the important considerations bearing upon such a selection.

It is possible that the zoning system, which is now being favorably considered in many American cities, will simplify the problem of determining the character of sewerage and drainage works to be provided. Whereas formerly it was impossible in many instances to forecast with accuracy the character of development which was likely to take place in the different portions of a city or to provide systems to meet all contingencies, the zoning system now facilitates more accurate forecasting of future sewerage and drainage requirements and there is greater assurance that the assumed future conditions will be realized.

The so-called "English system" has been advocated by some. In this, allowance is made in the separate sewers for such roof water as abutters may choose, or may be permitted, to discharge into them. In some places the unlimited disposal of roof water in this manner would result virtually in a combined system, since roof areas may well equal street areas, and where the community is thickly settled the extent of roofs may be three or four times that of the streets. It is doubtful, therefore, if the "English system," so-called, is of very general application. It must be conceded, however, that some extraneous water will reach separate sewers. Some roofs will be connected through error or surreptitiously. Some cellars will be drained, and some defective connections with sewers are inevitable. Reasonable allowance must therefore be made for such conditions.

Far greater care should be exercised in the construction of separate sewers than has been the case in many instances, in order that the sewers may not become overtaxed because of large quantities of ground water entering them.

Greater effort should be made to secure excellency of workmanship in the construction of house connections. In many cases sewers have been laid in an excellent manner and have been reasonably watertight. Later, however, through carelessness in the making of house connections these systems have been subjected to serious abuse. Mr. Dittoe* has suggested that,—

> . . . . The most logical and effective method of accomplishing this is the construction by the municipality of all connections to the public sewers from the building to the street sewer and the continuation of municipal control over such connections after they are constructed. The sewer department would organize its construction gangs for this work or would enter into annual contracts with responsible contractors, and the property owner would pay to the city the cost of construction, inspection, and recording.
>
> . . . . It is believed that this method of construction would insure better construction of the connection at lower cost, would largely prevent the misuse of sewers, and would assist in securing efficient operation of sewage treatment processes. Incidentally, it would probably arouse a more lively interest on the part of the city officials in the management and maintenance of the sewerage systems and would likewise remind the public that the system is an important feature of the community development and must be controlled in a business-like manner if its value is to be realized.

There is much to be said in favor of Mr. Dittoe's suggestion. Where connections are made by contractors, however, they should be licensed annually and should give bond for the faithful performance of their work.

More effective control of the construction and maintenance of house connections should be secured in many cases. Generally such control should be vested in the official in charge of the sewer system. When connections are to be made written applications therefor should be filed, and written permits for the connections should be issued. The official in charge should be notified when the work is to be done and should provide for the necessary inspection. A record of permits issued and used should be kept in a book provided for this purpose. The inspector's work should also be made a matter of record.

A few years ago the author had opportunity to observe the character of construction and inspection of house connections in Manchester, England. In this case the connections were completed before the inspector visited the work. The pipe line, however, was left entirely exposed, including the portion of the public sewer affected by the connection. Upon arrival of the inspector a plug was inserted at the branch in the main sewer and the connection subjected to slight hydrostatic pressure. In this instance there was no measurable leakage. Obviously, the connection was approved.

*Continued from page 95.

*Proceedings Am. Soc. C. E., December, 1921.

Co-operation between certain municipal departments is very important in securing satisfactory plumbing and house connections. The extent of such co-operation and the departments affected depend upon the local system of conducting the municipal work. The department which has charge of plumbing inspection should require the filing of sketch drawings showing the work contemplated. Before issuing permits for such plumbing these drawings should be submitted to the official in charge of the sewers, for his approval. If the drawing shows erroneous connection of roof water and fixtures within the building, the sketch should be returned to the plumbing contractor for the necessary revision. Until the drawings have received the approval of the sewer official the plumbing permits must not be issued. It is necessary that the plumbing inspectors understand the importance of the separation of roof water from sewage and that they shall conscientiously carry out the regulations to that effect.

It is also advisable to provide against incorrect connection made through error. In the City of Philadelphia the usual sewer and drain connections are 5 inches and 6 inches in diameter, respectively. Thus it is easy to determine with which pipes the plumbing systems should be connected. In another instance the bells of the cast iron pipes inserted into the foundation wall by the drain-layers are painted white in the case of storm water drains, and black in the case of sewers.

Complete and accurate records and record drawings of all sewers and drains should be filed in the municipal offices in a manner which will make them readily accessible for reference. As suggested by Mr. Dittoe, instructions as to the proper use of the systems should be provided by the engineers having in charge their design. Such instructions should be in permanent form and so placed, filed and disposed as to be always in evidence and available. Wall maps, house connection application blanks, permit books and permit blanks should have displayed prominently upon them the proper restrictions upon the use of the sewers and drains.

Suitable statutes or ordinances should be enacted to provide for the proper regulation of house connections. It is expecting too much of city officials to rely upon them to enforce such regulations unless they are specifically set forth in the state laws or in the municipal ordinances.

While much can be accomplished by such measures as have been suggested herein, after all, the success of systems of separate sewers and storm drains must depend primarily upon the integrity, loyalty, knowledge and backbone of the city officials in charge. They should recognize that it is one of their important duties, for the faithful performance of which they have taken oath, to see to it that the sewer and drainage systems are not misused and abused. There is no doubt that in many instances the strict performance of their duty will be unpleasant. In certain aggravated cases such performance of duty will doubtless result in a search for a new position. Nevertheless, it is the author's firm conviction that in many cases systems of separate sewers and storm drains can be saved from failure only by the loyal performance of this duty by the city official upon whom the responsibility devolves.

DISCUSSION OF THE PAPER

In discussion of this paper, A. Prescott Folwell presented some information obtained for him by the Clearing House of the society tending to show the extent of the misuse referred to. The replies were classified and combined as follows:

SEWAGE INTO DRAINS

The question was asked to what extent sewage from houses or elsewhere is discharged into storm water sewers (or drains) either under permission or regulation, or surreptitiously. Fourteen cities replied that this practice was not permitted; six that it was permitted, a seventh that it was permitted under temporary permit of the Board of Health in streets that were not yet sewered; and two that it was permitted under regulations. As to whether this was practiced surreptitiously, nine stated that it was to a small extent, one that about fifty instances could probably be found and seven that there was no such misuse.

To the question, to what extent industrial or objectionable wastes are permitted to be discharged into storm water sewers, nine replied that this was permitted, ten that it was not permitted, one that it was permitted for laundries; while to the question whether this was done surreptitiously, four stated that it was not; four that there was a greater or less amount of such misuse, and another that it was confined chiefly to garages.

Some industrial wastes are known to interfere with the treatment of sewage, and to the question as to the discharge of such wastes into sanitary sewers seven replied that there was no such discharge in their city; four that there was more or less, while a fifth specified two creameries, a sixth a gas plant, and two others stated that all industrial wastes were discharged into the sanitary sewers. In the case of combined sewers, eight stated that there was no such discharge; four that there was a slight amount, and two that all wastes reached sewers. Eight reported that discharge of these materials was done under permission and regulation by the city, four stated that no such discharge was done surreptitiously and five that there was more or less surreptitious discharge of such materials.

As to the kinds of industrial wastes reaching the sewers, three reported that wastes from tanneries and glue factories containing hair and lime reached the sewers; three reported wastes from textile industries containing cloth, fibrous material and objectionable compounds and solutions; three reported wastes from canning factories; two from stockyards; six from packing and rendering plants; one from wool-washing plants; four from dye works; ten from cream-

eries; three from gas factories; eleven from garages and two acid wastes from metal factories.

STORM WATER INTO SANITARY SEWERS

The question was asked to what extent roof leaders and area drains discharge into sanitary sewers. Four replied that such use was permitted; thirteen that it was not permitted, and two that there were a certain number of cases permitted. Four said that there was no surreptitious practicing of this, and seven that there were a few instances, but several others reported that "many" had infringed, "a vast number," "hard to control," etc.

The admission of sub-soil drainage to sanitary sewers from cellars, foundations, etc., was reported as permitted in seven cities, as not permitted in one city and as not practiced in six cities. The amount entering the sewers from leaky joints was reported to be none in two cities, small in one city, while others reported that it amounted to about 20 per cent. of the flow, 10 per cent. to 15 per cent., "considerable," "quite extensive," and others stated that it was "difficult to avoid," "difficult to determine," "unknown," etc.

In some cities storm water is admitted through inlets to the sanitary sewers, either from streets or other public thoroughfares, or from ditches or other open water courses. Fourteen reported that no storm water was admitted from streets, one reported that it was so admitted from all paved areas, five that there were some instances of it, and two that there was only one such instance. Admission from ditches and open water courses was reported from only two cities.

In general, the replies indicated a greater amount than had been suspected of permitted use of the different classes of sewers for purposes for which they are not theoretically adapted and which the writer believed are objectionable and should be eliminated wherever it is at all possible. As already stated, there is probably a great deal of surreptitious misuse of sewers in the manners indicated of which the authorities have no knowledge, but which should be discovered and stopped. In view of the millions of dollars invested in sewers and sewage- treatment works, this subject has not received the attention which it deserves from municipal authorities.

Catch Basin Cleaning in Chicago

Chicago continues to afford an illustration of how many cities of the country waste money by constructing worse than useless catch basins. The latest report of the Bureau of Sewers of that city shows a total of 128,596 catch basins in the city, while during the year covered by the report there were only 47,939 cleanings of basins performed.

This means that at least 100,000, or 75 per cent. of the basins, perform no service; for if a given basin is not cleaned at least twice a year, either it does not receive enough dirt to warrant its being there, or else it is full most of the time and does not function as a catch basin. In either case, the money used in building the catch-basin feature of the inlet was wasted, and the sediment that stays there indefinitely is almost sure to contain putrefying vegetable or animal matter that gives off obnoxious odors.

Sewage Treatment in England

Progress made during 1922, as summarized by the president of the Association of Managers of Sewage Disposal Works. Special interest in activated sludge.

In his presidential address last December before the Association of Managers of Sewage Disposal Works (England), Joseph Garfield gave a brief summary of the progress made in sewage treatment during 1922. The following summarizes the principal points of his address:

Interest centered chiefly about the activated sludge system. At Bury it was demonstrated that for that particular sewage it is necessary to break up the surface of the sewage in the tanks that was in contact with the atmosphere and not merely bring the successive layers of sewage in contact with the atmosphere; and similarly at Bradford it was found that a propeller rapidly circulating the sewage in a tank did not provide sufficient air to support oxidation unless the surface were broken.

At Davyhulme, Manchester, it was demonstrated that, should a dose of matter deleterious to the process enter the tank, it is best to continue operation and wash out the interfering substance rather than attempt to deal with it by prolonged aeration.

Referring to the opinion of some that an excess of forms of animal life in an activated sludge tank are inimical to the process, the speaker said that this idea was not generally accepted, and that the lower organisms generally destroyed the higher ones without difficulty.

Concerning the value of activated sludge as a fertilizer, Mr. Garfield said that desire to use the nitrogenous value of this sludge has probably made the problem of sewage disposal more difficult than it was formerly. In old days it was thought sufficient if the sludge could be rendered into a condition suitable for transport and thereby disposed of in some out-of-the-way place. Now we have to deal with a sludge which has great value on paper and the question arises: Will the dewatering of the sludge in this particular form be worth while? The markets of the world for this material theoretically are unlimited, but the actual markets from time to time are erratic. During the past year there has been a considerable demand for nitrogenous fertilizers containing not less than 4% of nitrogen. The price offered for this material in a dry, powdered form, packed in bags, had been $14 per ton at the producer's works. This material is wanted for export in regular large quantities, but will the market even

at this price continue? Again, one has to look not only at the local markets, but the markets of the world, when contemplating the huge production of a commodity which has not been available before. The city of Bradford for twenty years has put on the market large quantities of a fertilizer and grease produced from sewage sludge. The fertilizer was of a low grade but in a condition suitable to application to land. The chief markets in pre-war days were in France and Germany. The cost of transport, however, has so increased as to kill these markets.

"The recovery of successively increasing quantities of grease has thrown a large quantity of material on the market, which in times of bad trade it is not possible to dispose of. But the sewage of a city has to be disposed of irrespective of the markets, and it might be found that the activated sludge process would not be ruled out of court even if some process of further fermentation of the sludge had to be used, whereby a great deal of the manurial value was lost, but which resulted in the production of a smaller quantity of innocuous residue which could be more easily disposed of."

Mr. Garfield then described at some length an experiment carried out at Bradford as a substitute for chemical precipitation as a preliminary process. The Bradford sewage is exceptionally strong and would require considerable chemicals to secure coagulation. The experiment was made in a circular tank 14 feet diameter and 35 feet deep holding 30,000 gallons, 20,000 gallons per 24 hours being treated. Fresh sewage was run in at the surface of the tank and flowed out at a point 24 feet below the surface. It was aerated by compressed air delivered at the bottom of the tank through a ½-inch pipe with open end, and after prolonged aeration it was found that coagulation took place and sludge was precipitated in the same way as though a heavy dose of chemicals were used. The tank was operated as a continuous-flow tank and no suspended matter was allowed to accumulate in it. The effluent then passed through a sedimentation tank, the effluent from which was much clearer than obtained by chemical precipitation and in addition contained considerable dissolved oxygen and did not putrefy on standing. Chemical examination showed that the sludge in the sedimentation tank consisted of particles of suspended matter surrounded by particles of gas so small that it would require more than 20,000,000 to cover one square inch of surface. A noticeable feature of the action of this tank is the destruction of fats. The crude sewage contained 3½ tons of ether soluble fat per million gallons, while the effluent contained only a trace of fats, and in the sludge they amounted to only a half of those found in the crude sewage. The nitrogen content of the sludge is about 3%.

Municipal Lighting of Los Angeles

The City of Los Angeles recently purchased from the Southern California Edison Company for $11,000,000 the plant and equipment used in supplying electrical energy within the city limits. The city has installed several "super white ways" on various streets and is now giving attention to improving the lighting in the outlying streets and those business streets that are not included in the ornamental lighting area.

These streets will be equipped with pendant units operating 20-ampere series Mazda lamps suspended at street intersections. The pendants are of the Westinghouse Dustproof type, having two compartments, an upper ventilated compartment containing the auto transformer and a lower closed compartment containing a lamp. They will be equipped with the new Westinghouse bowl refractor of the closed type, seated on a felt gasket, thus entirely shutting out bugs and dirt from the lamp chamber.

Holophane refractors will be used, a type having been selected which will illuminate the area adjacent to the pendants as well as between them. This refractor consists of two pieces of pressed crystal glass nested one within the other and clamped together so as to form a single unit. The inside surface of the inner piece and the outside surface of the outer piece are smooth, so that the assembled unit can be cleaned easily. The outer surface of the inner piece is so provided with prisms as to bend downward the upward rays of light and also spread part of the downward rays; while the inner surface of the outer piece is fluted so as to reduce the brilliancy. This refractor greatly increases the light emitted at angles between 60 degrees to 85 degrees with the vertical.

Street Cleaning in Toledo

Details of methods and costs; also of garbage collection and sewage pumping.

In his report for the year ending Dec. 31st, 1922, S. A. Foster, commissioner of streets of Toledo, Ohio, gives some interesting figures and facts concerning the year's work. In his letter of transmission he says: "We have made every effort to carry out the promises and wishes of this administration to run the department on a business basis and carry no one on the payroll who was not efficient and willing to work full eight hours per day, thus cutting the old force approximately in half and accomplishing better results."

The streets were cleaned by machine, by hand patrol and by flushing, in addition to which the department removed the snow and cleaned catch basins.

All of the streets scheduled for machine cleaning received from 10 to 40 cleanings annually. Four sweeping crews were maintained and removed 26,437 loads of dirt and rubbish.

Hand patrol cleaning was used in the business district and in residential sections where it was requested. A daily average of 30 men and 3 teams were employed in this service.

Four crews were employed in flushing on both day and night shifts. Owing to the heavy traffic in the business section during the day, the streets here are flushed every night except Sundays during the Summer months. Approximately 14,000,000 gallons of water was used in flushing the streets.

During the year 7,241 loads of snow were removed from the streets in the central part of the city. Seven men and two single rigs were employed in catch-basin cleaning and 3,500 basins were cleaned during the summer months. Alleys also were cleaned by the department and 15,811 loads of ashes and rubbish removed from them.

The general cleaning cost $183,151, of which $20,290 was for men working at the city dumps. In addition, there were spent $24,687 for special street-cleaning, $5,684 for supervision, $1,999 for clerk hire, $33,992 for labor in shop and yard, $1,544 for miscellaneous and $828 for new equipment; giving a total expenditure of $251,855 for street-cleaning. In addition there was spent for street repair $147,146, of which $136,848 was for labor and $2,774 for new equipment. Garbage was collected at a cost of $122,043 and disposed of at a cost of $12,977. Sewers were maintained at a cost of $17,023 and an additional $3,045 was spent for labor and supplies at the sewer pumping station.

Most of the catch basins were cleaned by bucket and windlass, but 123 cleanings were by spoon shovels. 2,477 loads of dirt were removed from the 2,968 cleanings, or almost a load of dirt for each cleaning.

The sewage pumping station was opened early in November with four operators and three assistant operators and three laborers. Actual pumping of sewage began on Dec. 7th, on which date performance tests were started by Fuller & McClintock, the engineers, and by the contractor, A. Bentley & Sons Company. The pumping equipment consists of five motor-driven single-stage centrifugal pumps, four with a capacity of 36,000,000 gallons each per 24-hours and one of 24,000,000 gallons capacity. Space is provided for an additional pumping unit. At the end of the year the pumps had been operated a total of 91 hours and 41 minutes and pumped approximately 116,376,000 gallons of sewage, using 9,856 k.w.h. of current.

The garbage is collected by city-owned teams and trucks and part is delivered to the Pan-American Feed Milling Company and the remainder hauled to farms and plowed under. Twenty-nine teams and wagons, six 1-ton Ford dump trucks, two Ford roadsters and an average of 60 men, including drivers and helpers, with three foremen perform this work. The total amount of garbage collected was 14,966 loads estimated to weigh 25,495 tons.

A foreman and ten men are employed at the stables to take care of 100 horses and mules. A horseshoer and assistant shoe all the horses and mules used by this and the other municipal departments. One floor man, two blacksmith helpers and a wagonmaker do all the rebuilding and repairing on wagons, street sprinklers, flushers and white-wing carts and make the necessary repairs on trucks, and autos, and repair tools and implements used by the departments. Two carpenters do all the carpenter repairing for the departments besides work for other departments when necessary. One painter paints all the buggies, automobiles, etc., for this and the other departments.

The total expenditures for all of these services, together with the operation of a comfort station, was $718,065. During the year 1921 the expenditure was $1,173,000.

Pressed Steel Water Tanks

Water tanks abroad as well as in the United States have generally been constructed circular in form and composed of either steel plates riveted together or of reinforced concrete—the latter greatly in the minority, with wood staves for the smaller sizes. An English firm has introduced a type of tank made of pressed steel plates to be erected into rectangular tanks, the chief claim of which is that it does not require specially trained riveters or other skilled men and that transportation is easy into mountainous regions or other districts where transportation facilities are primitive. The individual plates are about one-third the weight of castiron plates used for the same purpose and are unbreakable.

The plates are in standard units 4 feet square and 5/16 or 1/4-inch thick, with flanges 3 inches wide and bolt holes 5/8-inch in diameter. Each plate is stiffened with ribs pressed into its outer surface. Any number of these plates can be bolted together so as to give various dimensions in multiples of 4 feet, both horizontally and vertically. For the corners, plates are used flanged on two adjacent sides and bevelled on the other two, the bevelled edges coming at the vertical and horizontal corner joints. The joints are made with strip of lead 2¾ inches by 1/8-inch thick laid between the flanges before they are bolted up and caulked tight from the inside of the tank. Stays are provided inside the tanks made of 2 1/2 x 2 1/2 x 5/16-inch angle bars, short stays being connected from the bottom to the first flanged joint and long stays to the upper tiers of plates.

The tanks are supported on towers of steel construction, one tank erected in India being 28 feet square and 12 feet deep and supported on nine vertical columns 26 feet high, these columns being capped with steel beams to support the flat bottom of the tank. Other towers have been erected at Sunderland, Birmingham and other cities of England.

Traffic Stripes on Roads

Nevada is painting a black center stripe on all its concrete pavements with a view to keeping traffic to the right and thus reduce the number of collisions. Last fall a small spraying machine was obtained for painting the stripe mechanically much more rapidly and cheaply than it can be done by hand. The machine is mounted on a truck which permits very rapid work.

Similar work is done in Michigan and to reduce the cost, Wayne County has developed a machine consisting of a DeVillibio compressed air painting machine mounted on a Ford truck. A wooden wheel about 2 feet in diameter and 4 inches wide and covered with a strip of felt about 1 inch thick revolves on an axle which is part of an iron frame attached to the rear of the truck in such a position that it follows in the track of the left-hand wheels of the truck. A spray of paint is applied directly

to the felt about 1 foot above the pavement and is immediately transferred to the pavement by the wheel. Although the pavement is concrete, white paint is used because much of the old concrete has been darkened by oil drippings, making a black line difficult to follow at night.

Before the painting machine is driven over the road, the center of the road is marked with chalk at intervals of 50 feet to guide the driver. In repainting an old line, the driver merely keeps his left-hand wheels on the old paint line. While hand painting required four painters to paint a mile of road a day, with the painting truck two men cover 6 to 7 miles a day.

Wisconsin Highway Notes

The Wisconsin Legislature on March 15th made immediately available the sum of $1,500,000 to meet federal aid in the same amount, thus placing in the highway construction fund the sum of $3,000,000. This bill provides merely for preliminary and immediate financing.

There is a surplus of $711,000 left over from last year's automobile license fees which, under the law governing maintenance, could not be spent this year for maintenance purposes. The Senate unanimously and the Assembly with only two votes against it passed a bill permitting this fund to be used to meet federal aid. The balance of the $1,500,000 above referred to is provided for by taking $789,000 from this year's license fund.

The bill decided upon by the joint highway committee for financing highway work for 1924-1925 arranges for raising $8,000,000 for state road construction and maintenance by a license tax on motor vehicles based on weight, beginning at $10 for a Ford car. It also provides for raising $3,000,000 by a 2c. tax on gasoline, this $3,000,000 to be distributed among the counties on the basis of the rural highway mileage of the counties, the amount received to be spent on such roads as the county boards may determine.

Highway Work in Louisiana

The Highway Commission of Louisiana spent more than $4,000,000 in 1922, included in this being parish funds and Federal aid. About 90 per cent. of the highways constructed last year were surfaced with gravel and the remainder with shell, Uvalde rock asphalt and bitulithic.

Soil carrying large amounts of iron is found in the northwestern part of the State which has been used as a binder instead of clay and is believed to be superior to it. By using this local material the roads have been built at a saving of from $2,000 to $3,000 a mile. Material said to contain 75 per cent. metal is being used on some of the highways as a base course. The city pays about 10c. a yard royalty for this material as against $1.00 a yard for freight on sand-clay and gravel.

It is stated that by the end of 1923 six cross-state highways will be nearing completion.

Highway Statistics

Compiled from information furnished to Public Works by the officials of more than three hundred counties and states, showing the sums spent in 1922 and available for 1923, the amounts and costs of each type of pavement laid, and certain details concerning use of reinforcement and methods of resurfacing old pavements.

Federal aid will be furnished to the amount of more than sixty-three million dollars during the fiscal year beginning June 30. To obtain this the states must appropriate an equal amount; except that ten of them, because of sparse settlement, need furnish only from 47 to 12.77 per cent of the total cost. On the other hand, many of the eastern states will spend several times the F. A. allotment. It therefore seems probable that considerably more than $150,000,000 will be spent on highway construction this year; and maintenance should run into even higher figures.

Taking the three hundred counties in the following tables, which are spread all over the country, as typical of the entire country, the expenditure this year will be almost exactly the same as last. The figures given us from these counties show about $70,000,000 spent by them last year and an estimate of $80,000,000 for 1923; but past experience would indicate that construction will probably fall somewhat short of the program.

Under the seven per cent provision of the Federal Aid law, 197,412 miles may receive federal aid, the total mileage of the country as certified by the several states being 2,820,165, Texas leading the states with a total of 182,816 miles. Of the total, more than two and a half million miles are only dirt roads.

These figures give some idea of the highway situation. Details on several points are furnished in the following tables, which have been compiled from information furnished to us by more than three hundred highway officials. These give the amount and cost of each kind of improvement done in each of the counties last year, and the amount contemplated for 1923; also the total expenditures of 1922 and the amount available for 1923. In addition, state officials have informed us as to the amounts spent by their several states last year, the amount that will probably be spent this year, how the state will raise its funds, and the kind and amount of work they expect to do.

(Continued on page 144)

COUNTY EXPENDITURES FOR HIGHWAYS

County and State	Total County, State and Federal Funds: Spent in 1922	Total County, State and Federal Funds: Available for 1923
Arizona:		
Coconino	$110,478	$100,000
Graham	200,000	500,000
Maricopa	5,000,000	2,000,000
Navajo	215,000	44,000
Pinal	84,448	75,000
Yuma	165,000	......
Arkansas:		
Polk	200,000	50,000
Colorado:		
Clear Creek	28,883	125,000
Costilla	50,000	......
Delta	190,000	145,200
Elbert	121,000	125,000
Logan	249,000	321,000
Mesa	277,135	194,900
Rio Blanco	51,062	67,000
Rio Grande	70,000	59,000
Sedgwick	94,000	59,000
Connecticut (Towns):		
Darien	116,270	60,000
Lynn	none	26,000
New London	32,000	......
Warren	3,500	3,500
Windsor	17,000	20,000
Delaware:		
New Castle	730,225[a]	500,000[a]
Illinois:		
Cass	250,000	350,000
Christian	347,000[a]	417,000[b]
DeWitt	38,000	30,000
Fulton	437,000	520,000
Greene	292,000	137,000
Hancock	......	30,000[a]
Jasper	140,000	......
Kane	700,000	1,000,000
Macoupin	41,000	89,000
Mason	20,000[c]	54,000
Massac	70,000	93,000
Monroe	20,000	20,000
Peoria	500,000	1,139,500
Pulaski	40,000	45,000
Randolph	5,000	30,000
Richland	......	13,000[d]
Sangamon	1,345,000	......
Stark	1,000	185,000
Stephenson	350,000	670,000
Whiteside	35,000[a]	80,000[a]
Will	64,786[a]	60,000[a]
Williamson	288,550	630,000
Winnebago	745,134	670,745
Woodford	53,163[a]	40,000[a]
Indiana:		
Henry	638,000	80,000[a]
Jasper	265,000	235,000
Jennings	157,678	125,000
Madison	600,000	......
Shelby	140,042	......
Vigo	929,490	5,500,000
Iowa:		
Adams	166,145	55,000
Appanoose	220,000	210,000
Audubon	300,000	40,000
Benton	125,000	115,000
Boone	179,797	150,000
Bremer	182,000	200,000
Buchanan	537,000	120,000
Buena Vista	98,600	120,000
Cerro Gordo	159,990	182,000
Chickasaw	232,000	75,000
Clay	200,000	200,000
Clayton	300,000	100,000
Crawford	150,000	250,000
Dallas	453,096	......
Decatur	174,000	164,000
Des Moines	58,200	......
Dickinson	77,238	115,450
Emmet	47,061	90,686
Floyd	......	70,000
Greene	100,000	140,000
Grundy	130,000	130,000
Guthrie	300,000	150,000
Hancock	480,000	110,000
Hamilton	300,000	170,000
Harrison	40,000	350,000
Howard	60,000	60,000
Jackson	90,000	175,000
Jefferson	75,529	135,304
Jones	180,000	200,000
Kossuth	850,000	90,000
Lucas	85,000	40,000
Lyon	24,560[a]	66,000[a]
Marion	152,499	295,000
Mitchell	198,000	114,000
Muscatine	187,000	136,000
Osceola	80,000	15,000
Pocahontas	143,133	120,000
Pottawattamie	600,000	100,000
Poweshiek	203,000	......
Iowa (Continued)		
Sac	230,000	250,000
Shelby	80,000	63,000
Tama	250,000	......
Union	100,000	150,000
Van Buren	90,000	200,000
Wapello	120,000	115,000
Webster	215,000	150,000
Woodbury	650,000	1,159,000
Worth	40,000	60,000
Kansas:		
Allen	389,597	......
Barber	24,801[a]	25,000
Barton	90,000	64,000
Bourbon	361,057	280,000
Brown	150,000	150,000
Butler	145,497	725,000
Cloud	......	40,000
Cowley	87,300	70,000
Crawford	929,085	250,000
Ellis	19,550	44,390
Geary	130,698	44,000
Graham	38,000	25,000
Gray	39,472	53,470
Harvey	33,500	34,300
Hodgeman	35,587	31,000
Jackson	77,000	110,000
Kingman	75,000	70,000
Labette	50,000	300,000
Lincoln	35,000	45,000
Lyon	240,000	600,000
Osage	79,859	62,500
McPherson	18,098	......
Ottawa	152,000	77,000
Rawlins	......	50,000
Reno	1,000,000	350,000
Republic	67,292	103,000
Sedgwick	1,000,000	600,000
Thomas	16,700	42,000
Wabaunsee	75,000	30,000
Kentucky:		
Allen	28,000	25,000
Boyle	45,000	109,000
Clark	450,000	300,000
Crittenden	24,000	32,000
Fleming	39,100	37,000
Gallatin	11,368	17,000
Jefferson	825,000	650,000
Oldham	30,000	......
Owen	15,000[a]	200,000[a]
Rockcastle	95,000	90,000
Woodford	75,000	50,000
Louisiana (Parishes):		
Beauregard	64,000	223,000
Caddo	665,000	700,000
Claiborne	......	150[a]
East Carroll	25,000	None
Lafourche	110,000	225,000
Lincoln	275,000	750,000
Ouachita	167,000	500,000
Rapides	......	400,000
St. Landry	653,460	600,000
Michigan:		
Branch	200,000	150,000
Cass	210,000	500,000
Charlevoix	150,000	170,000
Chippewa	291,815	200,000
Delta	300,078	242,000
Eaton	402,000	321,000
Emmet	318,000	......
Hillsdale	135,610	440,000
Kalamazoo	1,000,000	700,000
Kent	1,200,000	......
Keweenaw	132,429	175,000
Lake	100,000	50,000
Luce	77,000	113,000
Macomb	750,000	700,000
Muskegon	850,000	599,000
Ottawa	397,000	......
St. Joseph	74,808	217,000
Van Buren	162,348	127,546[a]
Minnesota:		
Aitkin	......	27,800[e]
Beltrami	224,162	89,562
Benton	78,364[f]	60,000[f]
Big Stone	58,151	50,000
Blue Earth	198,017	160,000
Brown	91,890	80,000
Carlton	90,479	100,000
Carver	146,000[g]	137,000
Chisago	110,000	90,000
Clay	104,219	120,000
Cottonwood	90,000	140,000
Dakota	327,890	235,000
Dodge	158,501	232,000
Freeborn	317,741[g]	173,000
Goodhue	293,022	185,000
Grant	67,117	65,000
Houston	85,000[h]	50,000[h]

COUNTY EXPENDITURES FOR HIGHWAYS—Continued

County and State	Total County, State and Federal Funds: Spent in 1922	Total County, State and Federal Funds: Available for 1923
Minnesota (Continued)		
Hubbard	58,107	20,000
Isanti	145,000	75,000
Jackson	253,000	300,000
Kandiyohi	200,000	110,000
Lake of the Woods[i]	34,528	20,000
Lincoln	109,008	211,955
Lyon	144,029[g]	210,000
McLeod	......	97,000
Mahnomen	34,092	15,860
Martin	159,300[a]	175,000
Meeker	250,000	150,000
Mille Lacs	30,200	40,000
Murray	150,000	67,000
Nobles	252,125	287,503
Norman	60,000	60,000
Otter Tail	360,000[g]	150,000
Pine	108,957	92,000
Polk	225,000	300,000
Rice	142,790	1,000,000
Rock	88,971	99,000
Sherburne	110,575	100,000
Sibley	136,000	123,000
Stearns	110,000	100,000
Steele	111,672[a]	110,000
Stevens	33,148	41,667[d]
Swift	70,742	190,000
Wadena	67,000	70,000
Washington	122,356	105,000
Watonwan	65,000	120,000
Wilkin	54,315	110,000
Wright	183,097	125,000
Montana:		
Cascade	265,000	370,000
Chouteau	25,000	20,000
Gallatin	501,391	120,000[m]
Granite	73,000	73,000
Hill	125,000	30,000
Madison	82,565	60,000
Missoula	56,387[a]	40,322[a]
Toole	50,000	5,000
Nevada:		
Esmeralda	2,000[a]	......
North Dakota:		
Cass	105,000	300,000
Eddy	......	25,000
Grant	75,000	70,000[h]
Hettinger	14,000	......
McLean	72,914	35,000
Ramsey	75,000	73,000
Traill	15,000	40,000
Williams	91,659	70,000[a]
Ohio:		
Allen	......	350,000
Ashtabula	1,377,500	800,000
Carroll	519,641	175,000
Clark	160,500[b]	156,650
Clinton	310,953	27,500
Fairfield	250,000	600,000
Hancock	435,000	......
Harrison	220,000	300,000
Henry	286,000	210,000
Holmes	271,700	275,000
Lucas	653,902	800,000
Madison	108,385	140,000
Marion	577,780	......
Medina	264,644	362,359
Ottawa	47,213	188,000
Paulding	167,000	110,000
Putnam	335,000	300,000
Richland	450,000	1,550,000
Ross	200,000	......
Sandusky	500,000	150,000
Trumbull	980,000	637,000
Van Wert	250,000	225,000
Warren	300,000	180,000
Oklahoma:		
Beaver	89,000	None
Blaine	53,957	52,200
Creek	267,400	......
Garfield	300,000	50,000[n]
Grady	68,000	60,000
Jackson	90,763	39,520[n]
McIntosh	10,000	26,000
Texas	110,492	105,000
Tillman	101,000	233,000
South Carolina:		
Abbeville	200,000	175,000
Anderson	171,000	50,000
Greenwood	57,443	70,000
South Dakota:		
Butte	50,000[a]	85,000[a]
Deuel	16,290	115,000
Grant	50,075	......
Hanson	43,785	50,000
Jackson	61,000[p]	59,000[p]
South Dakota (Continued)		
Kingsbury	73,000[a]	107,447
Mellette	6,000	14,000
Potter	18,000	40,000
Spink	175,000	110,000[a]
Sully	34,915	30,000
Tripp	150,000	100,000
Tennessee:		
Clay	16,000	40,000
Franklin	40,000	20,000
Grundy	......	190,000
Hancock	12,000	130,000
Johnson	20,000	18,000
Texas:		
Bowie	315,000	230,000
Brooks	4,850	129,000
Cameron	75,000	750,000
Coleman	250,000	1,306,500
Colorado	40,000	60,000
El Paso	504,896	165,000
Fannin	21,000	500,000
Fayette	195,000	400,000
Gillespie	60,000	60,000
Guadalupe	50,000	165,000
Harris	355,000	550,000
Hidalgo	368,000	2,250,000
Karnes	150,000	......
Kaufman	......	140,000
Palo Pinto	100,000	1,500,000
Red River	31,000	300,000
Rockwall	180,000	300,000
Runnels	30,000	40,000
Schleicher	170,000	124,000
Shelby	50,000	377,000
Smith	450,000	600,000
Tom Green	200,000	300,000
Uvalde	None	600,000
Wise	22,000	191,000
Virginia:		
Albemarle	485,000	600,000
Augusta	42,200	136,000
Pittsylvania	100,000	460,000
Tazewell	210,000	325,000[a]
Washington:		
Clarke	600,000	500,000
Ferry	50,000	210,000
Gray's Harbor	915,317	583,391
Jefferson	95,000	80,000
Lewis	244,384[a]	280,000[a]
Lincoln	288,000	377,000
Okanogan	125,000	150,000
Pend Oreille	158,000	196,000[r]
Pierce	240,617	463,275
Skagit	205,969	250,000
Wahkiakum	153,600	34,360[s]
Whatcom	321,100[b]	......
Whitman	315,000	500,000
West Virginia:		
Berkeley	150,000	100,000
Boone	225,000	164,000
Mineral	180,000	200,000
Taylor	156,450	......
Upshur	105,000	390,000
Wood	260,961	700,000
Wisconsin:		
Adam	48,286	24,000
Ashland	120,000	175,000
Bayfield	126,541	97,208
Florence	65,628	ap.57,000
Fond du Lac	1,134,046	1,500,000
Forest	125,000	125,000
Iowa	22,500	None
Jackson	125,146	105,757
Jefferson	......	1,300,000
Juneau	115,519	ap.120,000
La Crosse	540,000[a]	500,000
Polk	165,000	188,000
Richland	160,634	324,687
Sauk	125,000	300,000
Sawyer	130,000	148,000
Shawano	284,514	275,500
Sheboygan	413,733	320,936
Vernon	350,000[f]	286,000
Walworth	795,400	978,318
Waushara	91,000	64,000

[a]County funds only; [b]county and township funds; [c]on bridges; [d]State aid; [e]State only; [f]county and State aid; [g]does not include money spent by State on trunk roads; [h]does not include Federal aid; [i]new county—included under Beltrami Co. in 1922; [m]$124,000 additional for Federal Forest Service in this county; [n]until July 1, when new appropriations will be made; [p]township included; [r]also some Forest Service work; [s]does not include State funds.

ROAD IMPROVEMENT DONE IN 1922

County	Grading Amount Miles or sq. yds.	Grading Cost	Earth Surfacing Amount Miles or sq. yds.	Earth Surfacing Cost	Gravel Amount Miles or sq. yds.	Gravel Cost	Culverts and bridges included in cost
Arizona:							
Navajo	54	$750[m]			54	$2,500[m]	No
Pinal	3	4,272	31	$70,950			No
Yuma	42	31,500			17	68,500[g]	10 Corr. pipe culv.
Arkansas:							
Polk					15	10,000[gm]	25 bridges
Colorado:							
Costilla	18	30,000	5	5,000[g]			Yes
Delta	17	5,100[m]			20	83,000[gm]	4,778 ft. corr. pipe and 266 ft. concr. culv.
Logan					84	50,400[g]	4 bridges, 80 culv.
Mesa	7.5	18,000			7.1	100,000[g]	7 bridges and culv.
Rio Grande	63		5		4½		4 steel and 1 concr. bridges
Sedgwick		53,000			19.25	41,000[g]	7 bridges, 1 carload of culv.
Connecticut (Towns)							
Warren						200	
Windsor	80	5,000			1	1,000[g]	
Delaware:							
New Castle		113,401					
Illinois:							
Cass	100	30,000	125[h]	20,000			No
Christian	30	35,000	250[h]	150,000			No
De Witt	10	2,500[m]	100[h]	30,000[m]			No
Fulton	9	293,000	500	100,000[g]			Yes
Greene	15	80,000[d]					
Macoupin	505	60[m]					
Massac					10	20,000[g]	
Monroe	60						Yes
Peoria	3	30,000	110	330,000[g]			160 culverts
Pulaski	5	2,000[m]			3	3,000[gm]	
Randolph	1.5	5,000					No
Sangamon	97		62	9,000[g]			Yes
White	14				15	75,000	Culverts
Williamson					2	40,000[g]	Av. $2,500 per mile
Woodford	13.75	16,827	28	1,334			
Indiana:							
Jennings					5	24,284[g]	$12,000 total
Madison					11.5	36,235[g]	50 pipe culverts
Shelby					12.3	4,100[gm]	Yes
Vigo					25.1	100,240[g]	30 culv. and bridges
Iowa:							
Adams	7	43.714					
Appanoose	200,000 cu. yds.	29¼ cts.	85	98[m]			
Audubon	17.5	300,000					Culverts
Benton	35	50,000					No
Boone						18,200	
Bremer	13	82,000			7	28,000	45 culverts
Buchanan	6	23,000					
Buena Vista	1	5,000			9	12,000	No
Cerro Gordo	0.5	1,250[m]			20	1,650[m]	No
Chickasaw	24				10		42
Clay	7	30,000			40	57,000	No
Clayton	50	150,000			26	100,000	No
Crawford	15	120,000					
Dallas	58	1,786[m]			52	1,822[m]	No
Decatur	36.7	4,891[m]					
Dickinson					38	22,352	No
Emmet			21.75	4,268	26.5	18,226	20 culverts
Greene					20,000	19,000[g]	42 culv. and 1 bridge
Grundy	10	60,000			14	40,000	No
Guthrie	250,000 cu. yds.	30 cts.					
Hancock	24	50,000			14	15,000	No
Hamilton	100,000 cu. yds.	30 cts.			18,000 cu. yds.	2.00	No
Harrison	3	25,000	50	10,000			No
Howard	10.5	25,000			11	35,000	No
Jackson		48,300	1,100 cu. yds.	600			No
Jefferson	90,000 cu. yds.	27 cts.					
Jones	24	140,000			5	10,000	No
Kossuth	17	140,000			150	300,000[g]	
Lucas	6	45,000					26 culv. and 1 bridge
Lyon	28	24 cts.[y]			12	1,500[m]	
Marion			300	30,000			No
Mitchell	7	25,000			9	22,000	No
Muscatine	28.4	22¼ cts.[y]			7		
Osceola	13	25,000			17	34,000	No
Pocahontas					15	35,000	
Pottawattamie	50						
Sac	31	2,400[m]					
Shelby	5	25.5[y]					
Tama	30	170,000			2.5	7,500	
Union	97	8,500	154.5	35,000[g]			34 culverts
Van Buren	50	10,000					80 bridges
Wapello	10	46,000					No
Woodbury	20						
Worth	8	34,000			3	6,000	
Kansas:							
Allen	26	30,832	139	5,668			No
Barber	19	485[m]					Yes
Barton	3,000	50 cts.					No
Butler	2.5	2,000[m]	240	200[m]			No
Cowley	150	75[m]			7,920	7,920	No
Crawford	21	3,500[m]					No
Ellis	100	5,062					
Geary	88.5	143.[m]	88.5	44.86[m]			No
Graham	88	27,000	14	11,000			No
Gray	128	72.80[m]					No
	300	35.00[m]					No
Harvey	60	[illegible]	6	10,500			No

For foot notes see page 142.

ROAD IMPROVEMENT DONE IN 1922—(Continued)

County	Grading		Earth Surfacing		Gravel		Culverts and bridges included in cost
	Miles or sq. yds.	Cost	Miles or sq. yds.	Cost	Miles or sq. yds.	Cost	
Kansas (Continued)							
Hodgeman	32	$5,223	......	......	......	......	No
Jackson	49	19,870	......	......	......	......	No
Kingman	100	5,000	......	......	......	......	No
Labette	2.25	6,000[e]	......	......	10	$40,000	Culverts
Lyon	100	30,000	......	......	......	......	No
McPherson	......	......	......	......	3	......	No
Osage	......	......	207	$44,740[g]	......	......	....
Ottawa	......	......	80	42[m]	......	......	No
Reno	100	100[m]	......	......	......	......	....
Republic	55,000	15,850	......	......	......	......	No
Riley	......	10,000	......	......	......	......	....
Thomas	81.5	43.55[m]	......	......	......	......	....
Wabaunsee	80	5,000	......	......	2	4,000[g]	No
Kentucky:							
Allen	15	1,000[m]	......	......	6	2,000[gm]	Yes
Crittenden	8.5	2,800[m]	......	......	......	......	Yes
Jefferson	......	......	......	......	4	6,000[g]	....
Rockcastle	......	......	55	18,000	1	2,000	....
Louisiana:							
Beauregard	312	42,000	326	15,000[g]	62	......	84
Caddo	......	......	30	45,000	3	30,000	Few culverts
Claiborne	35	......	......	......	35	......	....
East Carroll	30	25,000	......	......	......	......	No
Lafourche	150,000 cu. yds.	30,000	......	......	17,000 cu. yds.	51,000	No
Lincoln	27	2,000[m]	......	......	27	8,000[m]	3 bridges
Ouachita	......	......	......	......	10	120,000[g]	4 bridges, 30 culv.
St. Landry	......	......	......	......	71.8	9,100[gm]	Yes
Michigan:							
Branch	......	......	......	......	40	160,000[g]	Yes
Cass	24	50,000	......	......	11	75,000[g]	Yes
Charlevoix	182,000	35 cts.	......	......	100,000	45 cts.	....
Chippewa	18	38 cts.[y]	......	......	5	......	....
Delta	5	5,000[m]	......	......	11	12,000[gm]	Yes
Eaton	26,386 cu. yds.	11,419	......	......	30,244	14,119	No
Emmet	......	......	......	......	28.5	231,340[g]	Many culverts
Kalamazoo	......	......	......	......	45	8,000[gm]	Culverts and 1 bridge
Kent	......	......	......	......	7.5	8,800[gm]	32
Keweenaw	7.5	......	......	......	3	......	....
Luce	4	22,000	......	......	3	20,000	300 ft. corr. culv.
Macomb	......	......	......	......	11	......	....
Muskegon	......	......	......	......	8.5	8,000[gm]	Aver. $15 per mile
Ottawa	6	3,200[m]	......	......	0.5	......	130 culverts
St. Joseph	......	......	......	......	16	54,808[g]	Yes
Minnesota:							
Aitkin	9	62,000	......	......	10	16,000	....
Beltrami	100.2	197,462	......	......	21.9	26,700	70 culverts
Benton	16	......	......	......	15	16,900	No
Big Stone	10.9	21,769	......	......	16.9	22,000	No
Blue Earth	45.2	79,856	......	......	44.2	78,025	130-ft. bridge
Brown	52	57,300	......	......	38	34,590	Small culverts
Carlton	62.7	1,230[m]	......	......	20.9	1,090[m]	4 bridges, corr. culv.
Carver (Co.)	19	76,000	......	......	24	30,000	Yes
Carver (State)	4	22,248	......	......	......	......	27 culverts
Chicago	......	......	......	......	7	32,000	No
Clay	50	50,000	......	......	15	30,000	Yes
Cottonwood	9	2,500[m]	......	......	28	1,500[m]	No
Dakota	25	4,450[m]	......	......	15	1,370[m]	30
Dodge	21.5	104,520	......	......	15.25	21,144	4 bridges, 20 concr. culv., 5,580 ft. pipe
Freeborn	53	135,754	......	......	19	20,035	10
Goodhue	42.3	135,940	......	......	54.7	92,777	21 concr. culv., 8,808 ft. corr. culv.
Grant	5	13,243	......	......	15	21,000	10 culverts
Houston	1.5	12,000	27	4,800	22	......	No
Hubbard	6.7	6,000	......	......	21.5	1,500[m]	....
Isanti	15	60,000	......	......	18	72,000	....
Jackson	60	80,000	......	......	33	90,000	No
Kandiyohi	70	180,000	......	......	......	......	320 ft. concrete
Lake of the Woods	19,888	10,515	8,175	6,005[g]	12,776	16,612[g]	No
Lincoln	27	96,392	......	......	11	12,615	22 concrete
Lyon	27.2	2,724	......	......	26.5	1,358	5,812 ft. pipe, 3 concrete, 1 bridge
McLeod	11	28,268	......	......	15	21,334	1 bridge
Mahnomen	5	26,140	......	......	......	......	2 concr., many pipe
Martin	10	53,500	......	......	23	40,600	....
Meeker	40	150,000	......	......	25	25,000	....
Mille Lacs	8	22,000	......	......	7	8,200	No
Murray	26	1,000[m]	......	......	42	800[m]	....
Nobles	30	68,440	......	......	36	62,733	Culverts
Norman	20	20,000	......	......	......	16,000	No
Otter Tail	40	260,000	......	......	24	35,000	200 culverts
Pine	56.5	60,889	......	......	8.5	2,464	....
Polk	80	181,000	......	......	......	......	19
Rice	337,360	99,693	......	......	34,880	43,098	No
Rock	......	......	......	......	25	38,866	No
Sherburne	16.1	42,934	......	......	13	17,592	Grading incl. 3 bridges, 1 concr. culv., 1,100 ft. pipe
Sibley	43	66,000	......	......	37	39,000	....
Stearns	14	35,000	......	......	21	18,000[g]	Yes
Steele	29.5	62,000	......	......	22	26,000	No
Stevens	14.1	21,092	......	......	......	......	No
Swift	8	34,228	......	......	......	4,000	No
Wadena	60	500	3	1,500	1	1,500	Yes
Washington	8	30,000	......	......	8	18,000	3 concr. culv.
Watonwan	8	19,000	......	......	28	46,000	No
Wilkin	7.4	13,458	......	......	7	24,787	2 concr. & 35 pipe culv.
Wright	35	58,825	......	......	26	27,160	....

For foot notes see page 143.

ROAD IMPROVEMENT DONE IN 1922—(Continued)

County	Grading		Earth Surfacing		Gravel		Culverts and bridges included in cost
	Miles or sq. yds.	Cost	Miles or sq. yds.	Cost	Miles or sq. yds.	Cost	
Montana:							
Cascade	......	$40,000	......	......	14.7	$122,000[g]	Yes
Chouteau	2	200	......	......	......	......	No
Gallatin	19.8	25,435	......	......	26.5	176,425[g]	Grading, 45 culv.; gravel, 120 culv.
Hill	18	......	......	......	18	......	No
Granite	......	65,000	......	$2,000	......	3,000	No
Madison	40	......	4	......	15	......	....
Missoula	18,000	32 cts.	16	97.40[m]	52,000 cu. yds.	1.35[y]	No
Toole	30	270[m]	......	......	6.5	100[m]	No
North Dakota:							
Cass	100	20,000	......	......	......	......	No
Eddy	25	10,000	......	......	4	45,000	....
Grant	7,600	25 cts.	150	150[m]	1,000 cu. yds.	3.00[y]	No
Hettinger	150	9,000	......	......	3	5,000	....
McLean	10	50,000	......	......	......	......	1 bridge, 200 corr. culv.
Ramsey	19	50,000	14.5	25,000	......	......	6,000 ft. corr. culv.
Williams	97	39,270	19.5	48,231	2.18	4,158	2 bridges, 8 concr. culv., 2,042 ft. pipe
Ohio:							
Carroll	144,838	55 cts.	......	......	......	......	....
Clark	12,500 cu. yds.	6,875	......	......	208	71,500	No
Harrison	5	4,000	700	65,000	......	......	4
Holmes	......	......	......	......	9.85	109,900	Yes
Richland	13.5	54,000	......	......	2	16,000	Yes
Ross	......	......	......	12,000	......	11,300	No
Trumbull	1.25	5,000	......	......	......	......	Yes
Van Wert	......	......	......	......	1	3,707	4 bridges, 10 culv.
Warren	......	......	......	......	75	100,000	Yes
Oklahoma:							
Beaver	157.3	37.60[m]	28.3	30 cts.[y]	......	......	No
Blaine	......	8,885	......	......	......	625	6 culverts
Creek	15	5,000	10	2,500	......	......	....
Garfield	60	35[m]	......	......	......	......	No
Grady	......	......	10	10,000	......	......	10
Jackson	104	25.50[m]	......	......	2	13,000[m]	2 box culv.
McIntoch	......	125[m]	90	100[m]	......	......	....
Texas	40	4,000	20	1.50[s]	10	2.80[s]	No
Tillman	230	40[m]	......	......	......	......	22
South Carolina:							
Anderson	......	......	......	......	47.5	3,600[g]	8 bridges, 4 concr. culv.
South Dakota:							
Deuel	......	......	100	9,650	1.5	1,480	No
Grant	......	32,422	......	......	......	17,653	Yes
Hanson	112	26,842	......	......	6	7,200	....
Jackson	......	......	129	21,000	5.6	15,000	No
Kingsbury	64	8,203	......	......	12	30,241	Yes
Mellette	36	6,000	......	......	......	......	No
Potter	27	18,000	......	......	......	......	Culv. & 1 bridge
Sully	18,530	43 cts.	......	......	2,089	92 cts.	....
Tripp	30	140,000	10	10,000	......	......	8 concr. viaducts; 24 concr. culv.
Tennessee:							
Clay	10	10,000	......	......	1	500	No
Hancock	15	12,000	......	......	......	......	2 bridges
Johnson	20	......	......	......	......	......	....
Texas:							
Bowie	14	22,000	......	......	16	293,000[g]	11 bridges, 13 concr. culv.
Cameron	75	20,000	......	......	1	5,000[g]	10
Coleman	50	75,000	......	......	6	15,000	....
Colorado	50	5,000	......	......	4	6,000	No
Fannin	4.5	12,120	......	......	......	......	No
Fayette	80	8,000	......	......	32	187,000[g]	Yes
Gillespie	......	......	......	......	10	60,000[g]	15 culverts
Guadalupe	......	......	......	......	3.3	20,000[g]	No
Harris	10	20,000	......	......	10	23,000	....
Hidalgo	......	......	......	......	4.3	......	....
Karnes	......	......	40	1,500	......	......	No
Palo Pinto	20	40,000	......	......	7	14,000	....
Red River	......	......	......	......	......	81,000	1 culvert
Runnels	75	300	......	......	10	2,500	14
Schleicher	12	30,000	......	......	2.25	3,600	19 culverts
Shelby	50,000	16 cts.	2,000	30 cts.	......	......	No
Smith	80	2,900[m]	......	......	60	3,000[m]	No
Wise	20,000	4,500	......	......	......	......	No
Virginia:							
Albemarle	61	128,000	20	30,000	......	......	Yes
Augusta	......	......	......	......	2	6,000[g]	5
Tazewell	16	65,000	......	......	......	......	No
Washington:							
Clarke	30	80,000	......	......	45	160,000	Yes
Ferry	6	75[m]	......	......	4	1,250[m]	....
Grays Harbor	......	......	......	......	20	15,000	Culverts
Jefferson	......	......	2	14,000	5	35,000[g]	1090 ft. of culv.
Lincoln	26	78,000	......	......	26	81,000	No
Okanogan	12	300[m]	......	......	10	8,000[gm]	Yes
Pend Oreille	......	......	6	9,000	9	90,000[g]	3 bridges; 20 culv.
Pierce	22.15	142,464	......	......	......	......	....
Skagit	......	......	......	......	1.3	5,640[g]	5
Wahkiakum	6	......	......	......	6	......	....
Whatcom	......	......	......	......	28.7	190,900[g]	50
West Virginia:							
Berkeley	100	500[m]	......	......	......	......	No
Boone	......	225,000	......	......	......	......	4
Mineral	15	100,000	......	......	......	......	Aver. $3,000 per mile
Taylor	6	36,000	......	......	......	......	Yes
Upshur	16,000	......	......	......	......	......	....
Wood	5.3	58,681	......	91,837[g]	......	......	Aver. 400 ft. apart

For foot notes see page 143.

ROAD IMPROVEMENT DONE IN 1922—(Continued)

County	Grading		Earth Surfacing		Gravel		Culverts and bridges included in cost
	Miles or sq. yds.	Cost	Miles or sq. yds.	Cost	Miles or sq. yds.	Cost	
Wisconsin:							
Adams	14	13,804	9.5	34,482	......	......	1 bridge, 6 culvs.
Florence	33,916 cu. yds.	40.5 cts.[y]	......	......	8,531 cu. yds.	1.87[y]	....
Fond du Lac	18	59,979	......	......	18	84,000[g]	Yes, except 12 mi. of grading
Forest	14	45 cts.[y]	......	......	6	1.75[y]	5
Jackson	93.75	20,222	6	1,800	8	6,500	No
Juneau	3	10,155	9	35,954[g]	2	23,000[g]	5
La Crosse	80	160[m]	......	......	......	......	13
Polk	16	1,845[m]	......	......	18	1,600[m]	....
Portage	......	......	......	......	34	67,000	....
Richland	8	17,834	......	......	6	98,342	No
Sauk	8	40,000	......	......	......	......	30
Sawyer	20	65,000	......	......	10	20,000	8 bridges, $12,000
Shawano	......	......	......	......	12	61,710	25 culverts
Sheboygan	6	7,500	......	......	75	140,980[g]	22 bridges, 83 culverts
Vernon	17	51,700	2	7,000[g]	0.25	1,700[g]	9 bridges, $48,000
Walworth	......	......	......	......	6	26,356[g]	1 bridge, 57 concr. culv.
Waushara	21	15,000	......	......	100,000	76,000	No

[g]—Includes grading. [h]—Oil treatment. [i]—Includes surfacing. [m]—Per mile. [n]—"Stamp sand." [s]—Per square yard. [y]—Per cubic yard.

ROAD IMPROVEMENT DONE IN 1922

County.	Bit. Macadam (M) and Bit. Concrete (C).		Cement Concrete (R = reinforced.)		Brick.	
	Amount. Miles or sq.yds.	Total Cost.	Amount. Miles or sq.yds.	Total Cost.	Amount. Miles or sq.yds.	Total Cost.
Arizona:						
Graham	....	....	6	$150,000[d]	....	....
Maricopa	....	....	200	22,000[m]	....	....
Colorado:						
Logan	....	....	2.3	69,000	....	....
Mesa	....	....	1.25	43,890	....	....
Connecticut (Towns):						
Darien	1.25M	$15,400[e]	3.33	85,000	....	....
New London	2M	32,000[e]	....	....	....	....
Windsor	....	....	....	....	....	....
Illinois:						
Cass	....	....	7	200,000	....	....
Fulton	....	....	2	44,000	....	....
Greene	....	....	8R	192,000[b]	....	....
Jasper	....	....	7	132,000	....	....
Kane	....	....	170,000	2.00[s]	....	....
Peoria	....	....	2R	59,000[e]	....	....
Richland	....	....	9R	252,000[d]	....	....
Sangamon	....	....	47	1,225,000[d]	....	....
Stephenson	....	....	10	300,000	....	....
Wayne	....	....	12R	....	....	....
Williamson	....	....	6.8	208 550[d]	....	....
Winnebago	....	....	16	422,544	....	....
Indiana,						
Henry	....	....	20	550,000	....	....
Madison	....	....	15½	480,200[d]	....	....
Vigo	....	....	10.42	370,600[d]	8.75	$525,000
Iowa:						
Buchanan	....	....	17R	402,000	....	....
Hancock	....	....	14R	360,000	....	....
Kossuth	....	....	11.05R	320,000	....	....
Woodbury	....	....	15R	....	....	....
Kansas:						
Allen	....	....	8	276,300[b]	....	....
Barton	....	....	36,000	2.50[s]	....	....
Bourbon	M	317,649	....	....	....	....
Brown	....	....	R	100,000[d]	....	....
Crawford	....	....	.26	27,000[m]	4	32,000[m]
Lyon	....	....	4	160,000	....	....
Ottawa	....	....	4⅓	2.82[s]	....	....
Reno	....	....	....	....	16	42,000[m]
Sedgwick	....	....	21	31,200[m]	5.5	53,000[m]
Kentucky:						
Boyle	½M	5,000[d]	....	....	....	....
Clark	C	33,933	....	....	....	....
Jefferson	....	....	4½R	180,000	....	....
Louisiana:						
Ouachita	1¼M	32,000[d]	....	....	....	....
Michigan:						
Cass	....	....	{ 6R 6 }	{ 170,000[d] 165,000 }	....	....
Eaton	....	....	5,111	12,573[sm]	....	....
Emmet	....	....	4¾	86,660[d]	....	....
Hillsdale	....	....	1½	45,000	....	....
Kalamazoo	7.5C	34,000[dm]	20	32,000[dm]	....	....
Kent	4.5C	30,500[dm]	5	20,160[dm]	....	....
Keweenaw	10M	18,264[m]	....	....	....	....
Macomb	3C	....	15	....	....	....
Muskegon	4¾M	21,000[dm]	{ 8R ½ }	2.30[s] 2.18[s]	....	....
Ottawa	....	....	{ 1R 7 }	30,000 28,000[m]	....	....
Minnesota:						
Houston	....	....	648R	1,820	....	....
Meeker	2C	57,000	....	....	....	....
Montana:						
Gallatin	5.5M	176,229[e]	....	....	....	....

ROAD IMPROVEMENT DONE IN 1922—(Continued)

County.	Bit. Macadam (M) and Bit. Concrete (C). Amount. Miles or sq. yds.	Bit. Macadam (M) and Bit. Concrete (C). Total Cost.	Cement Concrete (R = reinforced). Amount. Miles or sq. yds.	Cement Concrete (R = reinforced). Total Cost.	Brick. Amount. Miles or sq. yds.	Brick. Total Cost.
Ohio:						
Allen	9.00C 8.00M	....	1.00R	....	12.00	....
Ashtabula	247,000M	$578,500[d]	....	....	73,660	$799,000[d]
Carroll	5.84M	29,854[d]	....	....	9.45	36,540[d]
Clark	32,660M	58,213[a]	....	....	....	....
Clinton	....	....	....	....	7.55	42,500[md]
Erie	....	....	....	$175,000	....	....
Fairfield	3M	70,000	....	....	....	....
Hancock	36,000C	100,000[d]	29,000R	75,000[d]	....	....
Harrison	4M	139,000	....	....	....	....
Henry	4¾M	78,000	6¼R	123,000	....	....
Holmes	....	....	4.31	99,300[d]	2.5	62,500[d]
Lucas	118,350M	2.23[s]	38,871R 1,151	3.52[d] 2.92	....	....
Madison	7,479M	8,884	....	....	....	....
Marion	6.87M 2.06C	195,621[d] 52,855	....	....	7.6	214,310[d]
Medina	2.63M	44,894	1.74	33,500	....	....
Ottawa	....	....	3.62R	93,000	0.99	41,000
Paulding	....	....	6.06R	150,000	....	....
Richland	3.0M	50,000[d]	1.5R 4.5	60,000[d] 110,000	1.5	45,000[d]
Sandusky	....	....	1.5R	25,000[d]	11.3	38,000[d]
Trumbull	3.39M 2.55C	90,955[d] 44,883	15.92R	445,419[d]	5.66	233,727[d]
Van Wert	....	....	6R	148,000[d]	....	....
Warren	7M	152,000[d]	....			
Oklahoma:						
Blaine	....	....	....	R7,212 2,966	....	....
Creek	....	....	5	27,800	....	....
Garfield	6C	33,000	....	....	....	....
South Carolina:						
Greenwood	....	....	1.1	29,000[d]	....	....
Texas:						
Cameron	....	....	15,000 cu. yd.	50,000[d]	....	....
Guadalupe	5M	30,000	....	....	....	....
Palo Pinto	....	....	R 3,000 cu yd.	46,000	....	....
Rockwall	....	....	5.3R	....	....	....
Runnels	....	....	....	....	14,000	2.86[s]
Schleicher	12M	169,000[d]	....	....	....	....
Tom Green	10M	161,000[d]	....	....	....	....
Washington	....	....	32R	864,000	....	....
Virginia:						
Albemarle	M	204,000	....	123,000	....	....
Tazewell	2M	3,000	....	....	....	....
Washington:						
Clarke	5.5C	143,000[c]	8	240,000[c]	....	....
Grays Harbor	....	....	6	30,000[c]	....	....
Lewis	....	....	5,532	13,558[c]	....	....
Pierce	....	....	38,000	98,153[a]	....	....
Skagit	....	....	9.88	200,329[d]	....	....
Whatcom	....	....	6	130,200[d]	....	....
West Virginia:						
Taylor	4.16M	108,100[d]	....	....	3,200	12,350[d]
Upshur	....	....	19,300	61,500[a]	....	....
Wood	5.3C	....	3.4	107,443[d]	....	....
Wisconsin:						
Fond du Lac	....	....	33.76R	979,040	....	....
Forest	....	....	5R	22.00[y]	....	....
Jackson	....	....	½R	10,515[s]	....	....
Jefferson	39C	....	39R	....	....	....
La Crosse	32M	12,000[m]	....	....	....	....
Richland	....	....	¼R	7,748[a]	....	....
Sheboygan	....	....	0.5R	3,500[d]	....	....
Vernon	4,000M	8,000[c]	30,000R	110,000[c]	....	....
Walworth	....	....	28R	700,451[d]	....	....

NOTE: Cost includes grading unless otherwise noted. [a]Does not include grading. [b]Includes bridges. [c]Includes culverts. [d]Includes bridges and culverts. [m]Per mile. [s]Per square yard. [y]Per cubic yard.

Highway Statistics

(*Continued from page* 137)

In a later issue we will give additional data concerning the use of reinforcement by the different counties and the materials used by them in resurfacing old pavements. Also additional data similar to the above received too late for inclusion in this issue.

The following information was given in answer to the questions: How much money, including County, State, Federal and other appropriations, was spent during 1922 for highway work in your county, under county or state supervision?

How much money is available (County, State, Federal and other funds) for highway work in your county in 1923?

Please give the amount (in miles or square yards) of each kind of road improvement done last year under state or county supervision, and the cost of each for the season.

What kinds of highway work and what amount of each do you contemplate doing in 1923?

Highway Engineers in Demand

The American Association of Engineers reported a few days ago that, in view of the fact that the highway programs for this year aggregate nearly three-quarters of a million dollars, "very few highway engineers of experience are available for employment, and it will be necessary for the highway commissions to engage inexperienced men for their staffs or obtain young men who are graduating from universities this year."

ROAD WORK CONTEMPLATED FOR 1923

County	Kind and Amount of Work.
Arizona:	
Flagstaff	Grade and drain earth roads.
Graham	16 mi. concrete or asphalt.
Phoenix	Concrete.
Navajo	Gravel construction, $30,000.
Pinal	40 mi. grading.
Yuma	42 mi. bit. concrete, 30 mi. gravel surface.
Arkansas:	
Hempstead	2.7 mi. concrete or asphalt.
Polk	Finishing last year's grading & graveling.
Colorado:	
Cheyenne	Grade 30 miles.
Clear Creek	Gravel and rock work.
Costilla	Grading.
Delta	5 mi. gravel surf., 600 ft. steel bridge.
Elbert	Grading and bridges.
La Plata	8 mi. gravel, 30 mi. grading.
Logan	2.7 mi. concrete, 30 mi. gravel, 2 concrete bridges, 2,500 mi. maintenance.
Mesa	Graveling $35,000, grad'g $30,000, bridges, culverts, etc., $30,000.
Rio Blanco	1.8 mi. grading and gravel, reconstruct 50 mi. earth.
Rio Grande	Grading $59,000.
Sedgwick	1,600 ft. bridge $40,000.
Connecticut: (Towns)	
Darien	150 mi. bit. macadam.
Fairfield	2 mi. gravel.
Lynn	8,000 ft. plain macadam.
Warren	Repair dirt road and culverts.
Windsor	Grading, plain macadam, gravel, repairs.
Delaware:	
New Castle	Maint. 180 mi. improved & 770 mi. earth road; concrete & bit. concr. constr.
Florida:	
Broward	Asphalt surface on existing macadam.
Glades	8 mi. plain macadam.
Pinellas	Bonds for 90 mi. hard roads to be voted on May 2.
St. Lucie	8 mi. bit. macadam, 26 mi. w. b. macadam, surface treated.
Illinois:	
Cass	25 mi. grading, oil 150 mi.
Christian	Bridges, culverts, grading, oiling.
De Witt	Maintenance only.
Fulton	100 mi. earth surface, 2 mi. concrete, 45 bridges, culverts.
Hancock	Grading.
Kane	22 mi. concrete, resurfacing gravel.
Mason	7 mi. gravel, 10 mi. concrete.
Massac	29½ mi. gravel.
Monroe	Grade and oil.
Peoria	22 mi. concrete, 100 mi. grading, 160 mi. oiling.
Pulaski	Grading $35,000, gravel $10,000.
Randolph	Grading.
Richland	Grading and bridges.
Sangamon	Reinforced concrete roads.
Stark	6 mi. concrete road with bridges.
Stephenson	20 mi. 18-ft. concrete.
Wayne	100 mi. grading.
Whiteside	10-ft. concrete road, $80,000.
Will	Bridges $15,000, roads $190,000.
Williamson	22 mi. concrete.
Winnebago	10 mi. concrete, macadam and gravel.
Woodford	Grade & bridges 10.5 mi.; maint., resurface and oil 42 mi.
Indiana:	
Henry	Reditch & resurface with gravel & stone.
Jasper	Gravel and crushed limestone.
Jennings	Macadam $115,000, gravel $10,000.
Madison	7½ mi. concrete, 1 mi. gravel, 75-ft. steel bridge.
Posey	Gravel roads.
Shelby	Gravel roads.
Vigo	10 mi. vibrolithic concrete, 18 mi. gravel.
Iowa:	
Adams	7 mi. grading.
Appanoose	Grading, bridges and culverts.
Audubon	Blade grading only.
Benton	Repair $40,000, bridges $75,000.
Boone	Grading $25,000, graveling $25,000, bridges and culverts $75,000.
Bremer	18 mi. grading, 10 mi. graveling.
Buchanan	2 mi. concrete.
Buena Vista	4 mi. gravel, 18,000 ft. culverts.
Cerro Gordo	20 mi. grading, 20 mi. graveling.
Chickasaw	10 mi. grading, 32 culverts.
Clay	7 mi. grading, 20 mi. graveling.
Clayton	15 mi. grading & draining, 15 bridges.
Crawford	20 mi. earth road reconst., 20 mi. gravel.
Decatur	Grading and bridges.
Des Moines	Pave 1¼ miles.
Dickinson	Graveling $12,000, resurfacing gravel $12,000, bridge $10,000.
Emmet	Resurface and gravel 18 mi.
Floyd	21 mi. road.
Greene	20 mi. permanent grade & gravel, bridges and culverts.
Grundy	10 mi. grading.
Iowa (Continued)	
Guthrie	125,000 cu. yds. grading, 26 bridges and culverts.
Hamilton	75,000 cu. yds. grading, 20,000 cu. yds. graveling.
Hancock	15 mi. grading and graveling.
Harrison	20 mi. grading.
Howard	2 mi. permanent grading, 10.5 mi. graveling, 10 mi. tiling.
Jackson	Grading $100,000, bridges $70,000.
Jefferson	21 mi. grading, 80,000 ft. tile.
Jones	25 mi. grading, 10 mi. gravel.
Kossuth	18 mi. concrete, 16 mi. grading.
Lucas	Maintenance only.
Lyon	42 mi. grading, 15 mi. gravel.
Marion	20 mi. grading, drains, bridges & culverts.
Mitchell	13 mi. gravel, 6 mi. grading, 50 concrete bridges.
Osceola	11 mi. grading, 16 mi. graveling.
Pocahontas	25 mi. extensive resurfacing of gravel (500-1,000 yds. per mile).
Pottawattamie	Grading.
Sac	20 mi. gravel surfacing, $80,000 for bridges and culverts.
Tama	30 mi. earth road.
Union	10 mi. permanent grade, 50 mi. blade grader, 50 bridges and culverts.
Van Buren	16 mi. primary road grading $100,000, bridges $40,000.
Webster	Graveling & grad. $60,000, bridges $60,000.
Woodbury	25.5 mi. concr. paving, 16.5 mi. heavy grading and bridges and culverts.
Worth	15 mi. grading, 7½ mi. gravel, 6 bridges, 30 culverts.
Kansas:	
Allen	16 mi. concrete, 4 mi. gravel, 13 mi. bit. macadam.
Barber	75 mi. grading $4,500, 2 conc. bridges $6,000, conc. overflow $2,000, 9 culverts $2,500, paint steel bridges $2,000.
Barton	2⅜ mi. grading and bridges.
Bourbon	19 mi. bit. surfc., 4 mi. bit. mac. on 18 ft. brick, uncompleted work on contract $15,192.76.
Brown	Culverts & bridges $60,000, 10 mi. grading.
Butler	10½ mi. brick, 6 mi. gravel, 240 mi. grad.
Cloud	75 mi. temporary grading.
Crawford	3 mi. conc. 18 ft. wide, 4 mi. bit. macadam, 5 mi. chat.
Ellis	110 mi. grad., cuts, fills & dragging.
Geary	Earth grading & culvert work.
Graham	3 mi. earth surfacing.
Gray	400 mi. blade grader $14,000, fills & cuts, 27,700 cu. yds. $8,310.
Harvey	Grading and sand surfacing.
Hodgeman	27 mi. grading, 67 mi. regrading.
Jackson	8.79 mi. earth work and bridges.
Kingman	Backfill to bridges constructed previous year.
Labette	12 mi. grading, 25 mi. gravel resurfacing.
Lincoln	Grading, cuts & fills $25,000, bridges and culverts $20,000.
Lyon	11 mi. pavement.
Osage	Heavy grading, $20,000.
Ottawa	60 mi. blade grading, ¾ mi. 18 ft. to 50 ft. pavement.
Rawlins	90,000 cu. yd. earth grading, bridges and culverts.
Reno	4 mile brick paving, 2 large rein. concrete bridges.
Republic	Grading, constr. bridges and culverts.
Riley	Graveling, grading.
Sedgwick	6 mi. conc., 6½ mi. brick.
Seward	8½ mi. clay surfacing, 11 mi. blade work. 4 mi. fills by Fresno.
Thomas	Resurface all earth work, 3 bridges.
Wabaunsee	100 mi. grading, 2 mi. gravel.
Kentucky:	
Allen	Grading and graveling.
Boyle	11 mi. resurfacing macadam.
Clark	Surface treated waterbound macadam.
Crittenden	8½ mi. surfacing, 8.8 mi. gravel & drain
Gallatin	Only patching and maintenance.
Jefferson	8 mi. waterbound macadam, 4 mi. gravel.
Oldham	Repair only, $40,000.
Rockcastle	3 mi. grade and macadam, 5 mi. macadam.
Whitley	15 mi. surfacing.
Woodford	Reconstructing, surface treatment.
Louisiana:	
Beauregard	38 mi. gravel, 34 mi. gravel surface.
Caddo	12 mi. paving over old gravel & macadam.
Claiborne	16 mi. sand-clay gravel.
Lafourche	8 mi. concrete road.
Lincoln	63 mi. gravel road.
Ouachita	7 mi. asph. conc., 25 mi. gravel surface
Rapides	60 mi. gravel road.
St. Landry	Gravel rd. with conc. culverts & bridges.
Michigan:	
Branch	9 ft. gravel, 24-ft. grade, $120,000; 18-ft. conc., 26-ft. grade, $30,000.
Cass	12 mi. conc., 11 mi. bit. mac., 10 mi. gravel.
Charlevoix	7 mi. conc., 4 mi. gravel.
Chippewa	13 mi. grading, 8 mi. mac., 5 mi. gravel.

ROAD WORK CONTEMPLATED FOR 1923—(Continued)

County	Kind and Amount of Work.
Michigan (Continued)	
Delta	8 mi. mac., 15 mi. gravel, 1½ mi. concrete.
Eaton	8½ mi. gravel, 5½ mi. concrete.
Emmet	3 mi. conc. or bit. macadam, 24 mi. gravel.
Genesee	39 mi. gravel, 1½ mi. pavement.
Hillsdale	20 mi. 16-ft. gravel, 1 mi. 20-ft. concrete.
Kalamazoo	7 mi. gravel, 8 mi. waterbound macadam, 12 mi. pavement.
Kent	5.5 mi. grade, 18 mi. gravel, 15.4 mi. conc.
Keweenaw	New construction $100,000.
Lake	8 mi. gravel.
Luce	6 mi. grade, $25,000; 1½ mi. gravel, $9,000. 5 mi. water bound macadam, $46,000.
Macomb	20 mi. cement concrete, 6 mi. gravel.
Muskegon	13½ mi. concrete, 8 mi. surface treated macadam, 23 mi. gravel.
Ottawa	6 mi. grading, 15 mi. rein.-conc. pavement, 2 conc. bridges.
St. Joseph	8 mi. concrete, 15 mi. gravel.
Minnesota:	
Aitkin	Gravel $27,800.
Benton	12 mi. grading, 10 mi. gravel surfacing, 10 mi. clay surfacing.
Big Stone	8½ mi. grading and graveling.
Blue Earth	30 mi. grading, 30 mi. graveling.
Brown	Grading and graveling and 1 bridge.
Carlton	50 mi. grading, 32 mi. gravel.
Carver	11 mi. new grading & graveling; old work 2.4 mi. grading, including 1 culvert & 2 concrete bridges.
Chisago	Construct, $30,000; bridges, $10,000.
Clay	Grading.
Cottonwood	Grading, $40,000; bridges, $52,000; gravel, $15,000.
Dakota	30 mi. grading, 20 mi. gravel.
Dodge	22 mi. grading, 30½ mi. gravel.
Freeborn	10 mi. grading, 25 mi. gravel.
Goodhue	60 mi. gravel, 22 mi. grading.
Grant	15 mi. grading.
Houston	1 mi. grad. (heavy), 25 mi. light grading.
Hubbard	6 mi. grading and surfacing.
Isanti	Grading and gravel surfacing.
Jackson	50 mi. grading, 55 mi. gravel surfacing.
Kandiyohi	70 mil. gravel surface.
Lake of Woods	Some construction.
Lincoln	40 mi. grading, 24 mi. gravel.
Lyon	41.3 mi. grading, including 7,172½ ft. portable culvert material & 531.15 cu. yd. monolithic culverts, 9 mi. regravel, repaint 9 steel bridges, 14.35 mi. gravel.
McLeod	13 mi. grading, 16 mi. gravel.
Mahnomen	Grading.
Martin	20 mi. grading, 30 mi. gravel surfacing, 10,000 lin. ft. guard rail, 270 cu. yd. concrete bridges & culverts.
Meeker	Grading, gravel, bridges and culverts.
Mille Lacs	Grad., gravel & 1 20-ft. re-concrete bridge.
Murray	25 mi. grading.
Nobles	Grading, $186,000; gravel, $60,000.
Otter Tail	5 mi. guard rail, 13 mi. gravel, 8 mi. grading, 1 bridge.
Pine	30 mi. grading.
Polk	35-50 mi. grading.
Red Lake	25 mi. grading, bridge & culvert work, 3½ mi. gravel.
Rice	32 mi. gravel, 84 mi. grading.
Rock	27 mi. gravel.
Sherburne	Grading & gravel or clay surf., $60,000.
Sibley	30 mi. grading; 39 mi. gravel.
Stearns	25 mi. grading, 20 mi. gravel.
Steele	32 mi. grading, 20 mi. gravel.
Stevens	7.95 mi. grading, 71,000 cu. yd. earth rds.
Swift	Grading & culverts. $90,000; bridges, $40,000; surfacing, $30,000.
Wadena	50 mi. grading, 5 mi. earth surfacing, 1½ mi. graveling.
Washington	3.5 mi. grading & graveling.
Watonwan	13½ mi. grading, 20 mi. gravel surface.
Wilkin	19 mi. grading.
Winona	15 mi. grading, 15 mi. gravel, 30 mi. turnpike with blade grader.
Wright	15 mi. grading, 30 mi. gravel.
Montana:	
Cascade	24½ mi. gravel, $276,000; mostly earth. rd., some gravel surface.
Chouteau	Nothing but necessary repair work.
Custer	Same as in 1922.
Gallatin	20 mi. gravel surface roads, 15 mi. grading and draining roads.
Granite	16 mi. grading, gravel 15-ft. wide.
Hill	12 mi. grading and gravel surface.
Madison	8 mi. Federal aid, 20 mi. county.
Missoula	12 mi. grading and gravel.
Nebraska:	
Cheyenne	12 mi. Federal aid.
Grant	Grading and earth surfacing.
Lancaster	Earth work and bridge construction.
New York:	
Montgomery	¼ mi. mac., 1 mi. resurfacing, earth roads.
Warren	5 mi. bit. macadam.
North Dakota:	
Cass	19 mi. grading and graveling.
Eddy	10 mi. Federal aid.
Foster	11 mi. Federal & State aid grading.

County	Kind and Amount of Work.
North Dakota (Continued)	
Grant	Earth, some graveling.
Hettinger	10 mi. Federal highway earth.
McLean	Small amount Federal road.
Morton	Grading only.
Ramsey	16 mi. grading, 16 mi. gravel on graded roads.
Traill	Grading 8 mi. county highway and 8 mi. Federal highway.
Williams	100.0 mi. grading, 30.0 mi. graveling.
Ohio:	
Allen	1 mi. bit. concrete, 9 mi. brick or concrete, 5 mi. plain macadam.
Ashland	10 mi. brick or concrete, some macadam resurfacing.
Ashtabula	15 mi. either 4-in. macadam or 4-in. brick.
Carroll	2.65 mi. brick, 5.10 mi. grading, bridges and culverts.
Clark	8-in. reinforced concrete, or bit. macadam or brick.
Clinton	.82 mi. bit. mac., 1.52 mi. waterbound mac.
Erie	2 concrete sections, 1 macadam section.
Fairfield	7½ mi. rein.-conc., 6½ mi. brick, 213 mi. county rd., 10 mi. township rd.
Harrison	All bit. macadam.
Henry	Macadam, $40,000; concrete or bit. macadam, $156,000.
Holmes	Grading, graveling, semi-monolithic brick and plain concrete.
Lucas	Cement concrete, sheet asphalt, brick, bit. macadam, asphalt concrete.
Madison	2½ mi. new gravel, 60 mi. resurfacing old gravel and stone roads.
Medina	2.67 mi. concrete, 1.5 mi. bit. mac., 5 mi. gravel, 3.76 mi. local stone, 4.71 mi. state road.
Ottawa	5.61 mi concrete
Paulding	3.56 mi. state rein.-conc. & bit. macadam.
Putnam	5 mi. Ky. rock, 35 mi. surface treating, 20 mi. plain stone.
Richland	Brick and concrete, $1,550,000.
Sandusky	4.1 mi. brick, 5 mi. macadam (repair wk.)
Trumbull	4.33 mi. brick on concrete base, 4.01 mi. concrete.
Van Wert	6 mi. rein.-conc. or bit. macadam.
Warren	87 mi. bit. macadam.
Oklahoma:	
Beaver	160 mi. grading, 72 concrete culverts.
Blaine	Bridges & culverts, $25,000; road construction, $15,000.
Caddo	Grading, graveling & claying, $80,000.
Creek	20 mi. either conc. or asphalt surfacing.
Garfield	Pavements & bridges & culverts, $30,000.
Grady	Surfacing earth rds. & concrete bridges.
Jackson	2 60-ft. steel trusses, 20 concrete culverts, 1,200 lin. ft. gravel 20-ft. roadway.
McIntosh	20 small culverts, $5,000.
Tillman	Rein.-conc. culverts, bridges, spillways & some hard surfacing.
So. Carolina:	
Abbeville	Finishing up top soil roads and improving others.
Anderson	Grading, top soil, gravel, 2 bridges.
Greenwood	1.13 mi. plain concrete, 7.14 mi. top soil.
So. Dakota:	
Butte	50 mi. earth grading, 3 or 4 bridges—$1,000 to $6,000.
Clay	36 mi. grading, 22 mi. graveling.
Deuel	100 mi. blade grader, 15 mi. earth grading, 20 mi. gravel surface.
Grant	11 mi. state and federal, 15 mi. county.
Hanson	Grading and bridge repairing.
Jackson	Grading.
Kingsbury	Grading and blading county roads.
Mellette	50 mi. grading. 20 bridges, bridge fills.
Potter	25 mi. new work, considerable repair on township roads.
Spink	Earth roads, graveling surface, culvert, small bridges (all by co. owned equipment); State finish 33 mi. old contract.
Tripp	30 mi. earth road.
Tennessee:	
Clay	35 mi. grading.
Grundy	5½ mi. mac., 10 mi. grading & draining.
Johnson	Repairing old grades, patching mac. rds.
Texas:	
Bowie	5.60 mi. gravel, 3,210 lin. ft. bridges, steel and creosoted timber trestles.
Brooks	10 mi. caliche base gravel top.
Cameron	21 mi. 18-ft. rein.-conc. rd.
Coleman	Gravel road, rein.-conc. & steel bridges.
Colorado	7 mi. gravel.
Fannin	5.78 mi. concrete, 41 mi. gravel.
Fayette	Gravel surface and concrete structures.
Gillespie	10 mi. gravel. 1 mi. bit. macadam.
Guadalupe	Gravel, $65,000; bit. macadam, $90,000; bridges, $10,000.
Harris	5 mi. reconstructed road.
Hidalgo	34.3 mi. 1-in. rock asphalt resurfacing, 51 mi. high-class pavement.
Karnes	14.5 mi. rock asphalt on macadam base.
Kaufman	10.74 mi. gravel and bit. top.

(To be continued)

STATE HIGHWAY WORK IN 1922

State	Federal funds received for 1922	Highway funds furnished by state	Spent for roads under direct state supervision	State aid to counties, etc.	State subdivision for road work
Alabama	$1,013,048	$1,427,595	$2,440,643	None	Counties
Arizona	....	....	3,466,960	None	Counties
Arkansas	1,550,000	300,000	8,300,000	......	Road Imp. Districts
California	2,551,143	16,628,822	18,179,965	None	....
Colorado	1,267,028	4,437,319	5,704,347	$707,570	Counties
Idaho	900,000	1,200,000	2,000,000	None	....
Illinois	2,164,187	2,164,187	22,453,661	None	Counties
Indiana	821,913	5,939,144	6,491,816	None	None
Kentucky	1,445,407	2,862,410	5,234,739	525,099	....
Louisiana	513,226	1,287,709	4,073,251	None	Parish and road district
Maine	1,039,603	3,181,727	5,726,613	818,000	Towns and cities
Maryland	427,086	3,670,000	4,100,000	None	Counties
Massachusetts	1,662,195	7,008,872	8,579,530	None	Municipalities
Michigan	1,324,239	10,000,000	20,789,698	1,407,835	Counties
Nebraska	1,500,000[c]	1,500,000[c]	3,000,000[c]	None	Divisions
Nevada	754,815	....	1,329.184	......	None
New Hampshire	305.922	1,262,511	2,564,233	None	....
New Jersey	1,180,480	5,410,195	11,223,037	$500,000 to counties, $525,000 to townships. Counties advanced to state $4,632,362	Counties and townships
New York	6,556,164	17,185,390	29,022.659	$4,706,160	Counties, towns and villages
North Dakota	1,450,432	345.148	3,118.600	221,966 (maintenance)	Counties and townships
Ohio	3,000,000	9,000.000	18,000,000	None	Counties and townships
Oklahoma	2,213,986	2,876.215	5,090,201	......	Counties and townships
Oregon	1,043,695	7,767,995	12,659.434	$1,024,558	Counties
Pennsylvania	5,482.123	21.561,361	37,186,866	118.309	Counties, boroughs, townships
Rhode Island	71,782	1,834,199	1,609.054	$20,600	Townships
South Carolina	1,499,566	1.701.361	3,200,927	587,885	Counties
Tennessee	2,746,154	3,650.000	5,404,858	789,000	Counties
Texas	5,317,283	2,905.693	17.900,000	2,905,693	Counties
Utah	927,336	1,305,222	2.232,557	None	Counties
Washington	956,063	6.264.847	7,220,910	None	Counties
West Virginia	534.907	4,500,000	5,000,000	......	Counties
Wisconsin	1,438,504	1.700,000	14,131.981	785,000	Counties
Wyoming	538,401	1,241,041	1,779,442	None	....

STATE HIGHWAY WORK IN 1923

State	Federal funds probably to be spent	Funds to be furnished by state	Method of raising funds	Work contemplated
Alabama	$2,000.000	$2,000,000	Bond issue voted in 1922	350 miles sand-clay, gravel, bit. concr.
Arizona	2,383,364	1,788,040[a]	Taxation	Grading and gravelling
Arkansas	(d)	....	Gasoline and auto license tax	All types from grading to sheet asphalt
Colorado	5,272,700	50 per cent	Bond issue	64 mi. concrete, 102 mi. gravel and sand-clay, 58 mi. grading and drainage
Idaho	700,000	500,000	County co-operation	6 mi. paving, 300 mi. gravel or crushed rock
Illinois	2,797,889	$2,797,889	Motor fees and bond issue	1,000 mi. rigid pavement, 100 mi. semi-rigid, 250 mi. heavy grading
Indiana	5,000,000	2,500,000	Auto licenses and gasoline tax	150 mi. concrete, 7 mi. brick, 17 mi. bit. macadam, 17 mi. gravel
Kentucky	1,000,000[c]	4,000,000[c]	Motor licenses, gas tax county donations. 3/40 sheriffs' revenue, 3/40 tax on bank deposits	120 mi. grading and draining, 40 mi. gravel, 60 mi. w. b. macadam, 80 mi. high type
Louisiana	600,000	5,000,000[b]	Vehicle license, gasoline tax, chauffeur licenses	Gravel surfacing and maintenance
Maine	1,065,912	3,400,000	State tax, auto fees, gasoline tax and bonds	2.24 mi. concrete, 30 mi. bit. macadam, 200 mi. gravel
Massachusetts	1,500,000	7,500,000	Auto fees and fines. assessments on municipalities and counties	Construction, $5.800.000; maintenance, $5,200,000
Maryland	554,540	2,650.000	Bond issue	150 mi., principally concrete
Michigan	2,400,000	10,000,000	Bonds	573 mi. gravel, 87 mi. stone and macadam, 318 mi. concrete
Nebraska	Legislative	appropriation	will be made about May 1st.	
Nevada	3,490,000	$205,000	10c. tax per $100. gasoline tax, fees from licensed racing	163 mi. grading and gravelling, 12 mi. gravel only, 4¼ mi. concrete, 12 mi. asphalt macadam
New Hampshire	306,000[c]	1,260,000[c]	Auto registration fees and appropriation	50 mi. construction. 50 mi. reconstruction. 25 small bridges
New Jersey	628,581	8,000.000	Sale of bonds voted in 1922	Not yet decided
New York	6,274.000	19,000,000	State appropriation	Various
North Dakota	875.000[c]	200.000[c]	Motor license fees	400 mi. grading, 200 mi. gravel surfacing
Ohio	4,000,000	9,000,000	Direct taxes	Brick, concrete, asphalt and macadam
Oklahoma	3,000,000	4,000,000	Auto licenses, gas tax, ¼ mill levy, gross production, county and township bonds	300 mi. gravel road, 150 mi. concrete or better
Oregon	1,700,000	8,600,000	Bonds, gas and auto tax, ¼ mill tax	40 mi. paving, 400 mi. surfacing, 250 mi. grading
Pennsylvania	2,500,000	5,000,000	Appropriation, motor licenses, etc.	Construction by contract, maintenance by state forces
Rhode Island	400,000	1,700,000	Motor registration and taxation	1.3 mi. sheet asphalt, 9 mi. bit. concrete, 20 mi. concrete, 14 mi. bit. macadam
South Carolina	1,500,000	....	Motor licenses, taxes, bond issues by counties	Sheet asphalt. asphalt concrete, concrete, sand-clay, top soil, gravel
Tennessee	2,500,000	2,500,000	Auto gas tax, county contributions	Various, from w. b. macadam to concrete with bit. surface
Texas	6,000,000	3,500,000	Auto registration fees	....
Utah	1,800,000	26 per cent	State road tax or county bonds	19 mi. grading, 150 mi. gravel, 25 mi. hard surface, 2 underpasses or overheads
Washington	1,500,000	7,000,000	1 mill tax, 1c. gasoline tax and motor vehicle licenses	70 mi. concrete, 110 mi. surfacing and 15 bridges
West Virginia	696,086	12,500,000	Part of $50.000.000 bond issue, auto registration fees	Closing gaps in and extending present state routes—concrete, bit. macadam, bit. concrete, gravel, w. b. macadam
Wisconsin	2,000,000	2,000,000	Auto licenses	375 mi. concrete, 1,000 mi. gravel, 1,000 mi. grading and draining only
Wyoming	1,100,000	1,650,000	Oil royalties, gas tax and appropriation	500 mi. grading, 250 mi. gravel surfacing, 2,400 mi. maintenance

[a]—$788,040 of this by the counties. [b]—Includes parish funds under state supervision. [c]—Approximate.
(d)—Federal aid held up until state legislature enacts necessary laws.

Recent Legal Decisions

APPROPRIATION BY TOWNSHIP FOR STATE ROAD THROUGH IT HELD VALID

The Nebraska Supreme Court, State v. Bone Creek Township, 190 N. W. 586, holds that in a county under township organization, a township or town is a subdivision of state territory, convenient in area, for the purpose of carrying into effect limited powers governmental in their nature. Included in these governmental functions is the statutory power to direct the raising of money by taxation for the construction and the repairing of roads within the township and to make contracts necessary to the exercise of such power.

A township may, within legal limitations, appropriate money to defray a portion of the expense incurred by the state in voluntarily paving a road within the township. Public roads constructed and controlled exclusively by the state or a subdivision thereof are not "works of internal improvement," within the meaning of that terms as used in the constitutional provision prohibiting "donations to any railroad or other work of internal improvement, unless a proposition so to do shall have been first submitted to the qualified electors thereof, at an election by authority of law."

GUARANTEE OF PAVEMENT AGAINST DEFECT FOR ONE YEAR DISTINGUISHED FROM GUARANTY OF GENERAL REPAIRS

If the contract guarantees general repairs from usual wear and common use for one year, without regard to defective workmanship or material, it is not within the power of the city to include such costs in a pavement contract to be assessed against the abutting owner on the street. This the Alabama Supreme Court, City of Albany vs. Spragins, 93 So. 803, approves as the general rule established by the authorities. But an obligation by the contractor in such a contract to replace defective parts in such pavements and repair all defects to conform to the specifications within a year from acceptance is, the court holds, "a guaranty of his work and the quality of the material furnished by him for one year; and this did not render the contract illegal. The authority to make such provisions in a contract gives the municipality the proper means of self protection against defective work and material."

A clause in such a contract requiring the contractor to insure the safety of the public by proper precautions as to fencing, watching and lighting during the progress of the work and to keep the city harmless from his negligence in this respect, "neither increases nor diminishes the cost and expenses of the pavement to be assessed against the property abutting, as it adds no duty or liability on the contractor except what is already placed on him by the law," and does not render the contract invalid.

SUIT ON CHECK DEPOSITED WITH BID FOR PUBLIC CONTRACT

The Minnesota Supreme Court holds, Independent School Dist. No. 102 v. Farmers, etc., Bank, 190 N. W. 539, that a demand for the payment of and suit brought to recover upon a check deposited in connection with a bid submitted for the performance of a public contract was in legal effect a declaration of forfeiture, though no formal declaration for that purpose was made.There was no abandonment of the contract arising from the acceptance of such a bid, or of the districts right of forfeiture and to recover on the check, by mutual consent or otherwise, from the unsuccessful efforts of the parties to change the terms of the bid after acceptance.

CONSTRUCTION OF AMBIGUOUS PAVING BID

Paving proposals to contractors contained the following. "Bitulithic upon 5-inch Portland cement, concrete foundation, header, and curb as specified to be included in the price per square yard for paving."

The successful bidder offered to do the bitulithic paving for a specified sum per yard. The bid also read: "The above bid includes all curbing shown on plans—5,320 header—curb—5,160 ft. combined curb."

The ambiguity of this language presented the question, in an action for alleged balance on the contract, whether the bid per square yard for the paving was intended to include the cost of header and curbing without extra charge, as the city contended it did. The Iowa Supreme Court holds, James Horrabin & Co. v. City of Des Moines, 190 N. W. 380, that as the ambiguity was formulated by the bidder and included in his bid, it must be construed most strongly against him, and that the contract based thereon made the basis of figuring the cost only the area of the bitulithic paving and not the combined area of paving and header and curb.

EVIDENCE OF COST OF COMPLETING WORK HELD ADMISSIBLE WHERE COMPLETION PREVENTED

The Maryland Court of Appeals holds, Trustees of Aitz Chain Hebrew Cong. v. Butterhoff, 118 Atl. 658, that in an action for breach of a paving contract, where it has been shown that defendant had refused payment of the amount shown by the engineers; certificate to be due him and had ordered him to remove his implements, the contractor's testimony as to what it would have cost him to complete the work was admissible to ascertain the profit he would have made if allowed to complete it, if not inadmissible for other reasons.

CITY MAY PROTECT ITSELF AGAINST UNNECESSARY CUTTING OF NEW PAVEMENT

The Illinois Commerce Commission holds that the right of a city to protect new pavement from unnecessary cutting by a public utility for a reasonable number of years after it is laid must be recognized.

CHARTER RIGHTS AND MONOPOLY OF WATER IMPOSING OBLIGATION TO SERVE PUBLIC

The Pennsylvania Public Service Commission, on the complaint of the village of Tuscarora, holds that a water company which, by reason of its charter rights and its pre-emption of the only available water supply is in control of the situation, is under a corresponding obligation to serve the public.